PART 13

PARTICULAR INSTRUMENTATION AND CONTROL REQUIREMENT

Content

PART-13

Particular Requirements – Instrumentation, Control & Automation

13.1 Introduction 1
13.2 Design Approach & Scope of Work 1
13.3 Interface to the Central SCADA Stations at MIS-2 @ Shimsha Bhavan and CP-24 Centralized SCADA center. 5
13.4 System Completeness 7
13.5 Field Instrumentation and Control 7
13.6 Instrumentation Design Criteria 8
13.7 Flow Measurement and Control 9
13.8 Thermal mass flow meter for gas (air) for continuous measurement of flow 11
13.9 Flow Switches (Load Monitor) 12
13.10 Rotameter 13
13.11 Level Measurement and Control 13
13.12 Radar Microwave Level transmitter: 13
13.13 Ultrasonic Level transmitter: 14
13.14 Float Switches 14
13.15 Sludge Blanket Level Monitor 15
13.16 Level Gauge (Float & Tape) 15
13.17 Sight Glass 15
13.18 Pressure Instrumentation 15
13.19 Temperature Instrumentation 17
13.20 Temperature Switches 18
13.21 Strain-gauge Load Cell Weight Indicator and Transmitters 18
13.22 Online Analytical Instrumentation 19
13.23 Auto samplers 27
13.24 Laboratory Instruments 28
13.25 Associated Lab Equipment: 36
13.26 Online Real Time Multi Parameters Continuous Monitoring System for Influent and Treated Tertiary Parameters for the TTP's 42
13.27 Particular Control & Automation Requirements 46
13.28 Design, Supply and Construction Requirements 46
13.29 Minimum I/O Requirements for Auto mode Control operation of the Plant: 51
13.30 Typical Drive Control Philosophy to be provided on a minimum shall be as follows: 52
13.31 Approved Vendor/Manufacturer/Make List-Instrumentation 54
13.32 Approved Vendor/Manufacturer/Make List-Automation 56

13.33 Supervisory Control and Data Acquisition System (SCADA) 58
13.34 SCADA Software Functions 59
13.35 Control Room Furniture: 66
13.36 Spares for PLC & SCADA 66
13.37 SCADA Hardware Requirements 67
13.38 Uninterruptible Power Supply (UPS) for Instrumentation, Control & Automation..... 80
13.39 SCADA Control Room design 84
13.40 Inspection & Testing Requirements for Instrumentation, Control and Automation equipment, other related equipment as required under specifications:..... 89
13.41 Training Requirements for Instrumentation, control and Automation works 95

PART-13

Particular Requirements – Instrumentation, Control & Automation

13.1 Introduction

This part covers the particular requirements for the design, engineering, supply, Factory inspection and testing, Field testing & calibration, installation & commissioning of the instrumentation, Control and Automation (PLC-SCADA based Control System inclusive of wireless communication system) and associated plants and materials for successful operation of TTP .

13.2 Design Approach & Scope of Work

This section outlines the particular requirements for the instrumentation, control & automation works. This section shall be referred in conjunction to the general requirements for instrumentation, control and automation works specified. Unless specified in this section to the contrary, the system provided by the Contractor and workmanship shall comply with the General Chapters of these Requirements.

Design Approach: The contractor shall submit the credentials of the agency which shall be executing the work for review and approval as per qualification criteria indicated in the general requirements Clause 8.5 before commencing any designworks. Only on the approval of the same, the contractor shall commence works for instrumentation, control and automation works required under this contract.Refer approved vendor list for instruments and automation. Additionally, the contractor shall note that the approved vendor list indicated in particular requirements is only for the product and not for executing agency to execute the work.

Scope of Work: The scope of instrumentation, control and automation (ICA) works for Tertiary Treatment Plants, TTPunder this contract shall comprise of the design, manufacture, supply, programming and configuration, off site testing, delivery to site, installation and erection, testing, commissioning, setting to work and provision of documentation for a complete instrumentation, control and automation system including the interfaces required to provide monitoring and control for a safe and efficient operation of the plant locally as well as remote monitoring from the centralized SCADA Center to be established under contract package CP-24 SHIMSHA Bhavan (to be established under separate contract under BWSSB Stage V project). The SCADA system shall be designed and configured to transmit complete TTP, TTP operational data (data transfer in bulk) to the centralized SCADA center's as indicated above. The SCADA mimics of the local SCADA for TTP shall be provided to the CP-24 package contractor for his design mimics at the centralized SCADA center.

The minimum scope of work for ICA at TTP under this contract shall include on a minimum, but not be limited to:

1) Design, supply, install, test and commission a dual redundant PLC based SCADA system including redundant communication System for TTP. The system shall include on a minimum , but not limited to process controller including its central process units (CPUs in redundant hot standby configuration), redundant communication modules, Local/Remote IO's (Simplex), control networks, servers, Historian server and software, operator workstations, engineering workstation and printers;
2) All servers for SCADA, etc. shall be redundant (Refer control system architecture)
3) Design, supply, install, test and commission field & analytical instrumentation for the Entire TTP;
4) Design, supply, install, test and commission lab equipment for the Entire TTP and the same shall be integrated in real time with the plant SCADA system.
5) Design, supply, install, test and commission chlorination system including its instrumentation and chlorination control units and its interface with TTP PLC based SCADA system;
6) Design, supply, install, test and commission individual process systems, Vendor Package PLCs, RIO panels etc. including its instrumentation and control system units and its interface with main plant PLC system;
7) Contractor shall note that, "No separate PLC system" for monitoring and control of process system by the process vendor shall be accepted. The process vendor cannot supply the plant control and automation system. All vendors have to satisfy the qualification criteria as indicated elsewhere in the document.

8) Design, supply, install, test and commission uninterrupted power supply system to supply the entire PLC based SCADA system including the Vendor Package PLC/ Remote I/O (RIO) systems and field and analytical instrumentation, wireless communication system, and lab equipment(as required);
9) Control room furniture include but not limited to industrial system consoles for placing servers, workstations and printer compartments, engineering workstation and printer compartment and ergonomic designed seating systems along with chairs and Almirahs.Refer vendor list for system console.
10) The Contractor shall be responsible for the design of each instrumentation and plant monitoring system, including the selection and design of appropriate transducers, transmitters, signal conditioning devices, indicators, alarm system programmable devices, communications, cable system etc. The Contractor shall take account in his design of all installation and environmental conditions prevailing at the site.

CONTROL SYSTEM – DESIGN & CONSTRUCTION FOR TTP

The PLCs and Input/output modules used for the Works shall be from the same manufacturer and series and shall as far as be practical allow for the interchange of plug in parts.

The PLCs and the central HMI shall be linked over dual line local area network (LAN) which shall be established on optic fiber cable with a single mode glass type.

A general arrangement of a typical control system is shown in the Drawings.
The control systems shall recover fully to a normal operational state on restoration of the power (either from the mains or the generator) after a power failure without manual intervention. (i. e. to remove doubt this requirement refers to a real failure of power to the control system such as would be experienced if the control system UPS s were not present).

In all cases, facilities shall be provided to permit these automatic controls to be overridden and the systems to be manually controlled.
Local manual controls shall be located adjacent to Plant where required for day to day operation. All drives essential for the continuous operation of the plant shall be provided with a standby.

The process control system must be state-of-the-art in terms of structure and function as a process information and control system and its hardware and software must be future-oriented. The control system should be a modern system with an appealing user interface, open to the office and process world, with sophisticated and reliable functions, efficient to configure and scalable for simple and complex tasks.

The communication channels modules for the connection to the Programmable logical controllers via various communications media must be included in the scope of delivery of the control system, the same applies to drivers for simple types of coupling such as point-to-point via the MPI interface. In addition, it should be possible to establish the coupling to other devices and applications from various manufacturers via the standardized software interface OPC.

On a minimum, the SCADA hardware shall be based on the following:

- Main computer (SCADA server) Windows® 2019 Server (latest version)
- Operator stations - Windows 10 Professional(latest version)
- Hardware and software from the PC sector can be directly used (e.g. LAN cards)
- Can be used as single-user or multi-user system with client/server structure

Scalable performance by selecting suitable hardware platforms.

Integral online parameterization option

A prerequisite is a comprehensive parameterization system that is integrated in the system, which allows the user to adapt the scope of functions and the functionality to any changed requirements without any programming expertise. The system must offer the option for carrying out these parameterization

operations online. In practice, this means that the respective editor can run in a second window during operation and the configuration engineer can make changes to his application without exiting process mode and also without affecting the background activities. In addition, it should be possible to make configuration changes on the client as well.

Hardware

The control system hardware shall consist of field controls which comprises on a minimum but not limited to:

PLC s;
Redundant power supplies;
local HMIs if any;
field cabling interfaces.
and central controls which comprises:
central SCADA and auxiliaries;
engineering station;
historian station;
CCTV System & Fire Alarm System inside Building;
Uninterruptible power supply & Battery Bank.

The site instrumentation shall also form an integral part of the control system.

The control panels shall provide separate areas for the PLC, internal power distribution, instrumentation, field cabling and for any surge (lightning) protection devices (SPD s). A separate instrumentation earth (a 'clean' earth) shall be established within the control panel. Instrumentation and control cable screens shall be connected to this earth.

The central controls (SCADA) shall be located in the administration building(SCADA control room) for the monitoring of the treatment plant which shall be at central location of the Plant. The complete PLC based SCADA system inclusive of the Vendor Package PLC/RIO systems shall be housed in AC environment. Requirement of Air conditioning, humidity control etc. shall be as per Manufacturer's recommendations for all PLC system cabinets, marshalling, RIO Panels as well as the Vendor Package PLC Systems.
The control room shall be designed to have a complete view of the TTP plant from the control room without any obstruction. Full scale glass windows shall be provided in the control room (from floor to ceiling), in addition to the false flooring and false ceiling. No cable shall be laid on the control room floor and the same shall be routed through ducts and conduits below the flooring. The contractor shall note that no UPS system and related battery backup system shall be installed in the control room. There shall be separate room provided for the UPS system.

Power Supply

The control system shall be powered from main Uninterruptible Power Supply System (UPS) located in the Panel Room of the Control Room with a separate room for Batteries. In general power supply for vendor package PLCs/ RIO panel or any other ICA System present in the field shall be supplied from same UPS system.

These shall be sized to provide sufficient power to maintain the control system (inclusive of Treated water quality monitoring instrumentation, vendor package instrumentation) systems functioning for a period of not less than 120 minutes on full load.

The UPS System shall be free standing provided with a bypass Transformer. The status of UPS shall be monitored and an alarm shall be raised via the control system if a fault occurs or the UPS battery supply is about to expire.

Voltages

The following control voltages shall be used:

Item	Voltage
1. within starter enclosures	240 V AC
2. instrumentation power supplies	240 V AC / 24 V DC
3. PLC inputs cards	24 V DC
4. PLC outputs	24 V DC

Control System Protection

1. **Short Circuit**
   All circuits shall be protected against short circuit by the provision of adequate numbers of fuses or miniature circuit breakers.
   For ease of maintenance and system security power supplies to each instrument loop and each PLC output shall be protected with an individual fuse (terminal type).

2. **Surge Protection**
   Surge protection devices (SPDs) shall be provided at the control panel end of all instrumentation and control cables which run for distances in excess of 50 m outside the confines of the building in which the CP is housed. The SPD s shall be grouped in a specific area within the CP to ensure 'dirty' signal cables do not come into direct contact with 'clean' signal cables.

Duty / Standby Drives

The duty pump for each duty / standby pair shall be selected at the local control panel and the Plant HMI.

The control logic shall automatically start an 'available' standby in the event of the duty drive failing. The new duty drive shall take on the role of duty drive in all respects and shall continue to run as duty until manually reselected to standby or it fails.

Interlocking

Hard wired interlocking shall be provided for safety circuits such as:

- motor protection;
- run dry protection;
- emergency stop circuitry;
- rotation monitor.

In addition drives stopped as a result of the action of hardwired interlocks shall in addition have a fault signal conveyed to the drive in order that the PLC drive run output is removed.
Soft wired interlocking is provided by the PLC for process control and for safety trips when the signal is derived from a remote source (e.g. stopping of the treatment plant as a result of a high level in a downstream Treated water Storage Tank).

Alarm Annunciation

Alarms shall be annunciated at three locations, at the drive starter, at the local Controller /RIO HMI as applicable and at the Local SCADA. A philosophy shall be adopted that all alarms associated with a drive shall be annunciated at the starter whilst a general alarm only for that drive shall be enunciated at the HMIs. Therefore the operator observing a general alarm at an HMI shall have to go to the starter concerned to determine the exact cause of the alarm condition.

Communication Monitoring

The control system shall continuously monitor LAN communications and raise an alarm at the central SCADA if communications should fail between the SCADA and a controlling PLC/Vendor PLC / RIO or between PLCs if inter-PLC communication is being used. A separate SCADA screen (mimic) showing the real time status of PLC's, I/O modules, LAN communication ,RIO status, etc. is to be incorporated.

13.3 Interface to the Central SCADA Stations at MIS-2 @ Shimsha Bhavan and CP-24 Centralized SCADA center.

(a) General

The process screens/mimics and all screens configured shall be made available to centralized SCADA system

(b) The Interface

The interface shall be housed in a separate IP-65 rated control panel provided by the Contractor. The Contractor shall provide facilities to output from the control system via this control panel the signals to be sent and to accept the signals provided. The Contractor shall provide the redundant GPRS wireless communication at the TTP control system and from TTP system to contract package CP-24 and BWSSB MIS-2 SCADA center at Shimsha Bhavan.

All required data from the TTP control systems shall be communicated to the Central SCADA Centres at Shimsha Bhavan and contract package CP-24 centralized SCADA center via wireless GPRS redundant network. Communication between the interface control panel of the Central SCADA System and the TTP control system shall be carried out by the TTP Contractor. The Contractor shall provide termination details to permit these connections to be carried out. The Contractor shall co-ordinate in full with other Contractors to interface with Central SCADA System so that the entire SCADA system for TTP system can be provided completely.

Interoperability Test & Integration co-ordination:
The TTP package contractor shall conduct a interoperability test to confirm & demonstrate that the local control system data can be read & written by the contract package CP-24 and BWSSB MIS-2 SCADA center at Shimsha Bhavan,using appropriate OPC server & client software via the interface panel and local PLC/SCADA. The test shall be carried out in presence & co-ordination with the centralized SCADA control centre contractor/system integrator.

It is required that the TTP Package contractor maps his local I/O's for integration in the same format as required at centralized SCADA control centre.

The TTP Package contractor shall co-ordinate fully with the centralized SCADA control centre contractor for integration tests .The TTP Package contractor shall be fully responsible for data to be made available at the interface panel end at all times, which is connected the integration system.

(c) Data to be provided by the TTP to MIS-2 SCADA and CP-24 Centralized SCADA center.

The TTP contractor shall provide complete SCADA screen dumps to enable complete TTP monitoring and control (as required) from the Centralized SCADA centers.

The following signals are to transmitted by the Contractor to the interface on a minimum, but not limited to:

- Treated water flow (Ml/day);
- Treated water parameters to confirm to contract conditions;
- combined filtrate flow (Ml/day);
- final turbidity (NTU);
- final chlorine residual (mg/l);
- power consumed / day (kWh);
- chemical consumption;
- total flow / day (Ml);
- power outage hours / day (h);
- power outage at treatment works;
- Complete plant maintenance record ;
- Real time online inlet and effluent monitoring system data;
- Total plant screen dumps
- Alarms
- Asset information with tags
- Reports
- Local Historian data
- Status of fire alarm and suppression system

Note:.

The minimum scope of work for ICA at TTP's shall include but not be limited to:

1) Design, supply, install, test and commission a dual redundant PLC based SCADA system for TTP. The system shall include on a minimum , but not limited to process controller including its central process units (CPUs in redundant configuration), redundant communication modules, RIO's as required, Simplex input-output (I/O) modules(Hot swappable), redundant I/'O's for critical inputs (around 15% of total I/O considered),control networks, servers, Historian server and software, operator workstations, engineering workstation and printers;

2) All servers for SCADA, etc. shall be redundant (Refer control system architecture)

3) Design, supply, install, test and commission field & analytical instrumentation for the Entire TTP;

4) Design, supply, install, test and commission chlorination system including its instrumentation and chlorination control units and its interface with TTP PLC based SCADA system;

5) Design, supply, install, test and implementation Interface to the TTP PLC based Control System.

6) Design, supply, install, test and commission individual process systems Package PLCs/ Local Controllers / RIO panels including its instrumentation and control system units and its interface with main plant PLC system; Any Vendor package process systems with Package Control System shall communicate with the main plant PLC for monitoring and control .

7) Design, supply, install, test and commission uninterrupted power supply system with 120 mins backup on full load, to supply the entire PLC based SCADA system including the Package PLCs, Equipment's Local Control Systems, Remote I/O (RIO) systems and field and analytical instrumentation and associated instrumentation, communication interface consisting of RTU and GPRS modems.

8) Control room furniture include but not limited to industrial grade system consoles for placing servers, workstations and printer compartments, engineering workstation and printer compartment and ergonomic designed seating systems, Almirah etc. Refer vendor list for system console

9) The Contractor shall be responsible for the design of each instrumentation and plant monitoring system, including the selection and design of appropriate transducers, transmitters, signal conditioning devices, indicators, alarm system programmable devices, communications, cable system etc. The Contractor shall take account in his design of all installation and environmental conditions prevailing at the site.

10) The contractor shall ensure that complete TTP plant operational data, all SCADA mimics inclusive of the Lab analysed data is made available to the integration panel of centralized SCADA system of CP-24,

11) All necessary required cabling, programming, software and hardware required to make the data available to the integration panel at all times, is part of the integral scope of work of the TTP contractor. The contractor shall co-ordinate in full and conduct interoperability tests with the centralized SCADA contractor to ensure data is compatible with the data format which is required.

13.4 System Completeness

This section of specifications defines the particular requirements of instrumentation, control & automation works to be installed at TTP .

Irrespective of the detailed specifications of the respective items detailed in the various chapters of the tender specification, the Contractor shall be required to provide all the equipment, accessories, cabling, earthing, providing necessary transducers/sensors, system hardware/software, programming logic, interlocks ,cabinets, panels etc. to achieve the functional requirements described in the Bid Document.. The System completeness shall be the Contractor's responsibility.

Note: In FAT, all the field instruments shall be tested for functionality as per contract requirements at the manufacturers work location where the equipment is manufactured. Quality assurance plan (QAP) shall be submitted along with the datasheets for review and approval before any inspections call is initiated.

13.5 Field Instrumentation and Control

Each field instrument shall be operable in local mode and have display functions in SCADA. The Contractor shall be responsible for providing the appropriate signals at the locations required to provide the specified control and monitoring functions.

The Contractor shall ensure that field measuring systems shall respond quickly to any changes of the measured process variables.

All field instruments shall, as far as practicable, be mounted in a location that shall be free of vibration and shall be powered from the instrument control system.

24V dc power wiring for field instruments shall be individually fused and provided with a means of disconnecting the power without disturbing terminated wiring (e.g. knife-switch-type terminal blocks). Visual indication of a blown fuse condition shall be provided.

All field instrument components shall be of a proven and reliable design and shall have a high degree of uniformity and shall, wherever possible, be interchangeable. The design shall facilitate easy maintenance and repair, taking into account the availability of access routes through plant and structures generally.

Field Instruments shall perform sensing, indicating, transmitting and controlling. The devices shall generally interface with the SCADA, either directly or indirectly. The materials of those parts of the field instruments, including piping material, which are exposed to the measured media shall be compatible with the conditions of the respective media and of the ambient fluid and atmospheric conditions.
All field instruments shall be mounted within enclosures that are corrosion proof, dust proof and waterproof to provide a minimum protection specified in elsewhere in this Specification. The enclosure shall be rated to minimum IP 65.The enclosure design shall be submitted along with the instrument datasheet for review and approval before any design of the same.

All field instruments, including the components, shall be tropicalized and designed for the ambient conditions detailed elsewhere in this Specification. Lighting protection barriers shall be used for protecting transmitters and receiving instruments from the surge voltage due to lighting strike. Lighting protection barriers shall be supplied at both receiving and sending ends for all signals from outside building and those installed between the buildings.

13.6 Instrumentation Design Criteria

The design criteria to be applied to instrumentation systems shall be as follows:

1) all instruments shall be suitable for continuous operation;
2) all transmitting instruments shall have a 4 - 20 mA HART linear output;
3) all digital outputs shall be volt free;
4) all instruments shall be designed for the ambient conditions of temperature and humidity;
5) all wetted parts of instruments sensors shall be non-corrosive and suitable for use with water;
6) all instrumentation systems for use out of doors shall be protected to IP 65;
7) all analogue displays shall be of the digital type with no moving parts utilising back lit liquid crystal diode LED technology;
8) instrumentation shall utilise solid state electronic technology and avoid the use where practical of any moving parts;
9) minimum maintenance requirement;
10) Instrumentation shall resume operation automatically on the application of power following a power failure.
11) All analytical instruments shall be single channel and have individual analyzer units.

Instrumentation systems shall be provided as detailed in the Employer's Requirements and as necessary for the efficient and safe operation of the treatment plant

The Contractor shall provide systems to measure any other parameter required for the efficient and safe operation of the treatment plant.

Instrumentation sensors shall be suitable for the environment in which they are expected to work. Sensor located in hazardous (flammable) or potentially hazardous atmospheres shall be certified for use in these areas.

All Sensors should be of self-cleaning type.

Instrumentation shall be selected and installed in accordance with the manufacturer's instructions. Wherever practical components of similar systems shall be interchangeable, i.e., open channel flume flow measuring systems and open sump or tank level measurement and pump control systems shall incorporate identical sensors and converter units. Instrumentation converter units shall where practical be located in the associated MCC common control panel well away from any injurious effects of the process.

13.7 Flow Measurement and Control

The Contractor shall use electromagnetic flow meters, for all closed pipe liquid flow measurement as the standard flow meters under this contract. Each flow meter shall be installed in the pipeline within a suitable access chamber. The access chamber shall be designed to provide adequate space for personnel access to the chamber and around the flow meter for maintenance. The flow meter system shall provide flow rate and totalized flow indication.

The pressure rating of the flow meter and flanges shall be equal to or greater than that of the pipeline within which it is installed. The preferred location for the flow meter converter/transmitter units is within a building. Where this is not possible, then the converter shall be installed in a suitable above ground enclosure providing the converter with suitable mechanical and environmental protection.

The flow signal converters/transmitters shall provide 4-20mA output linearly proportional to the rate of flow and shall provide a pulse output for flow totalizing. The flow meter electronic supervisory unit shall display the following on a minimum:

- Flow rate;
- Flow total-totalizer;
- High flow rate alarm;
- Low flow rate alarm.

Signals for the items above shall form inputs to the PLC and SCADA and be utilized within Operator displays. The integrator used for the second item above shall have at least six digits.

Each flow meter shall be provided with downstream and upstream isolation valve including the washout facility.

The sewage water inlet flow shall be measured using an open channel flume type system located in the inlet channel. The head loss across the flume shall be monitored using ultrasonic fully sealed detectors. A local readout of flow in Ml/day shall. be provided.

Electromagnetic Flow Meter

Full bore bi-directional electromagnetic flow meters shall be designed, manufactured and calibrated as per ISO/IEC 17025 standard. Meters shall also have actual Flow rate & Totalized value. The accuracy shall be +/- 0.5% of reading.

The sensors shall be as per ISO standard lengths (ISO 13359), so that inter-changeability can be carried out for the applicable flow meter sizes. The sensor shall also have built in grounding and empty pipe detection electrodes of SS316 for detecting partial flow condition & efficient operation purposes. The liner material shall be Polyurethane (PU). The sensor & transmitter shall be capable of working in tropical environment.

The sensors shall be rated IP68. The transmitter shall be rated IP67 in line with local operating conditions. Installations shall be made with cables and /or conduits that guarantee the integrity of the system under all operational conditions. The transmitter/ converter shall be wall-mounted type with a 2 line display for the indication of Actual Flow rate & Totalized value. A glass window within the protection enclosure with optical switches shall be provided for local reading purposes.

The enclosure material shall be non-corrosive and of die cast material. Magnetic flow meters should be supplied with built in software feature to analyze and continuously monitor the health of the sensor, display errors in text format. Transmitter should be capable of performing the verification program on demand or on request without taking meter off the line.
The transmitter shall be capable of being fully programmable. It shall have a set-up menu so that all relevant parameters may be user-set from the self-prompting driven menu.

The transmitter shall have totalizer units and shall have one (1) scalable pulse output & one (1) current i.e.4-20mA HART output. The current output shall be galvanically isolated. It shall be fitted with switched mode power supply

capability 0-250V or 24 DC and 45-65Hz to cope with power transients without damage. The Totalizer value shall be protected by EEPROM during power outage, and utilizes an overflow counter.

The transmitter shall be having facility of indicating flow measurement. It shall be possible to separate the sensor and transmitters up to 200 meters without the need for signal boosters or amplifiers

Detailed technical specification of Full bore electromagnetic flow meter is as below

General		
1	Application (Suitable for)	Treated Water /Effluent Water
2	Op Temperature	0 to 50 Deg C Max
3	Op Pressure	Max 6 Bar g
4	Measurement	Instantaneous water flow Rate, Totalized Flow
Flow Sensor		
5	Type	In-Line Full Bore Electromagnetic flow meter.
6	Power supply type	Mains operated
7	Sizes (mm) /Qty	As per flow sizing calculations
8	Sensor Type	Pulsed DC
9	Process Connection	Flanged type
10	Weather Protection Class	IP68 as per IS 13947
11	Full Scale Velocity	0.2 to 3 m/s, vendor to provide the detailed sizing calculations based on the process details.
12	Electrodes	SS 316 L, Total 4 Electrodes system. Measuring electrodes – 2 Nos. Grounding electrode- 1 No. and Empty pipe detection electrode -1 No.
13	Coil Housing	Powder-coated die-cast aluminium Anti corrosive grade with IP 68 protection class with minimum 20 meter cable for remote mount transmitter connection
14	Flanges	Carbon Steel PN 10 as per EN 1092-1
15	Flow sensor Grounding	Grounding rings shall also be acceptable
16	Flow Tube material	SS304
17	Flow Tube Liner	Polyurethane
Flow Transmitter Unit		
1	Type	Microprocessor based with facility to configure the range
2	Type of Display	2 -Line LCD display with operation keys (touch control)
3	Transmitter Type	Remote Wall Mounted with 5 cable glands, integrated fixing points for wall mounting, with sensor interface
4	Units for Display	Flow Rate m3/Hr, Totalized Flow ML

5	Input	From Flow Tube
6	Accuracy	+/- 0.5 % of Measured Value
7	Operation	Via local display, Via HART handheld terminal
8	Output proportional to Flow rate	Current output (4–20 mA HART); pulse/frequency/switch output (2); status input
9	Power supply	0-250 VAC, 45-65Hz – Optional - 11 to 40 V DC
10	Self-diagnostic feature	Following minimum diagnostic features shall be provided Empty pipe detection, system diagnostic features
11	Transmitter enclosure material	Non-corrosive, Die Cast Aluminium
12	Communication	Suitable for Wired communication with control system and HART based integrated and service interface
13	Memory	100% secure data storage
14	Weather Protection Class	IP 67 (NEMA 4X) for flow transmitter
14	Calibration Method	Gravimetric Method ISO 4185 / volumetric method (ISO 8316). All test equipment fully traceable to national and international standards with 5 point calibration.
15	Flow calibration rig	Duly Accredited according to ISO/IEC 17025

Note-1: The flow meter manufacturer/supplier shall have full ISO 9000 series accreditation and fully traceable calibration methods. The suppliers shall also have a testing facility in India so that methodology and procedures can be verified. Each meter shall be wet calibrated with 5 point calibration to verify performance in accordance with the specification & submit report for the same. The testing facility shall be duly accredited in accordance with ISO/IEC 17025 standards.

In the event if the meter manufacturer does not have a testing facility in India, the flow meter shall be tested & inspected before shipping at the Manufacturers factory works, where the meter has been manufactured.

Note-2: The flow meter manufacturer shall have local offices in India and full service capability in the major cities (metro's) throughout the country. Full contact details for key personnel, shall be furnished on request. The supplier shall provide evidence of at least five years involvement in the manufacturing of meters worldwide.

Note-3: The flow meter manufacturer shall provide full data on each meter required, including optimizing and sizing programs calculation sheet.

13.8 Thermal mass flow meter for gas (air) for continuous measurement of flow

Thermal mass flow meter shall be utilized as mass air flow meters to measure air flow or bio gas flow as applicable under this contract.
The sensor shall not cause any pressure loss and no pressure and temperature compensation shall be required. The meter shall be able to measure Mass flow, temperature, volume flow and energy flow

The degree of protection for the sensor and transmitter shall be rated to IP67.

Measuring Principle	Thermal dispersion principle
Sensor features	Shall offer high accuracy and repeatability for a wide range of utility and process gases.

Measuring Task	Flow (Mass), Gas temperature, Gas heat flow
Accuracy	+/- 1.5%
Sensor, Insertion tube material	Stainless steel
Compression fitting seal	PEEK
Material process connection	Stainless steel
Transmitter housing material, Coating	Powder coated die-cast aluminium, powder coating
Degree of protection	IP67 (NEMA 4X) for transmitter and sensor
Max. measured error	Gas: 1.5% or (10 to 100% o.f.s.)
Display/Operation	LCD/LED: back-lit, Configuration via local display and operating tools shall be possible
Outputs	4-20mA HART (active/passive selectable), pulse, frequency, status
Hazardous area approvals	Required (As applicable)

Note-1: The flow meter manufacturer/supplier shall have full ISO 9000 series accreditation and fully traceable calibration methods. The suppliers shall also have a testing facility in India so that methodology and procedures can be verified. Each meter shall be wet calibrated with at sufficient flow rates to verify performance in accordance with the specification & submit report for the same. The testing facility shall be duly accredited in accordance with ISO/IEC 17025 standards.

In the event if the meter manufacturer does not have a testing facility in India, the flow meter shall be tested & inspected before shipping at the Manufacturers factory works, where the meter has been manufactured.

Note-2: The flow meter manufacturer shall have local offices in India and full service capability in the major cities (metro's) throughout the country. Full contact details for key personnel, shall be furnished on request. The supplier shall provide evidence of at least five years involvement in the manufacturing of meters worldwide.

Note-3: The flow meter manufacturer shall provide full data on each meter required, including optimizing and sizing programs calculation sheet.

13.9 Flow Switches (Load Monitor)

1) The load (kW) monitor shall be suitable for mounting within the appropriate motor starter section of the motor control centre. The device shall be used primarily to detect low or no flow situations. However, it may be utilised to detect overload situations where appropriate.
2) In low or no flow mode the load monitor shall monitor drive power. If the measurement of the power falls below an adjustable set value (P-min) an output-relay shall be de-energised to cause the pump set to stop.
3) The monitor shall incorporate the following features:

a) DIN-rail mounting
b) adjustable start-up delay time
c) adjustable reaction time
d) three monitoring measuring ranges, selected externally on unit
e) normally energised, or de-energised mode
f) output signal may be latched, or automatically reset
g) LED indicators for mains on indication and status
h) Relay output; 1 No. changeover contact.

4) The monitor performance specification shall be as follows:

a) Reaction time - 3 to 30 seconds adjustable
b) Start-up delay time - 0.15 for 20 seconds adjustable

c) Switching capability - 1 A (24 V), 0.1-8 A 250 V ac, 1 100 VA)

d) Maximum switching current - 10 A

13.10 Rotameter

Type	On-line up to 2". By-pass above 2"
Metering tube	Borosilicate glass
Float	AISI 316-SS unless the process fluid demands some other material.
Body MOC	AISI 316-SS
Scale	Graduated- Engraved black on white background.
Process connection	Flanged
Accuracy	± 2% of full scale detection or better for on-line type and ±4% of full-scale detection or better for by-pass Type.
Nameplate	Tag number, service engraved in stainless steel tag plate
Accessories	Slip-on orifice plate of 316-SS and taps of Stainless Steel as per application requirements. Applicable

SS Isolation valves and SS Range Orifice – for Bypass type rotameters.

13.11 Level Measurement and Control

The following section describes the minimum technical specifications for level measurement and control under this contract.

Owing to the nature of sewage and sewage sludges, non-contact methods of level measurement are preferred. Where foaming problems are identified as a local concern, the level measurement by level transducer shall be considered. Float switches are reserved as backup to the level indicating transmitters.

Sensing heads shall be mounted on 316 stainless steel brackets and positioned to ensure an unhindered beam path and ease of access for maintenance.

13.12 Radar Microwave Level transmitter:

	Transmitter	
1	Type	Microwave Level measurement
2	Principle	Pulse Time of flight
3	Output	4-20 mA HART current
4	Housing	Die Cast Aluminum
5	Electromagnetic compatibility	Interference Immunity to EN 61326, Annex A (Industrial) and NAMUR Recommendation NE 21 (EMC)
6	Ingress Protection	IP 67
7	Accuracy	+/- 3 mm
8	Area Classification	Non-Hazardous. Hazardous
9	Display	4 line LCD display. Service: Display of Envelope curve.
10	Configuration	Using Keypad on display
	Sensor	

11	Range	Liquids 0 to 5m and 0 -10m depending on Tank size
12	Temperature range	-40°C ... +80°C
13	Max Pressure	3 bar abs
14	Materials	Sensor: PVDF Seal: EPDM
15	Antenna seal	FKM Viton
16	Process connection	Threaded or universal flange dependent on model selection
17	Degree of protection	IP65

13.13 Ultrasonic Level transmitter:

	Transmitter	
1	Type	Ultrasonic
2	Principle	Pulse Time of flight
3	Output	4-20 mA HART current
4	Housing	Die Cast Aluminum
5	Electromagnetic compatibility	Interference emission to EN 61326; Equipment class B Interference immunity to EN 61326; Appendix A (Industrial)
6	Ingress Protection	IP67
7	Accuracy	+/- 2 mm or 4 mm depending on selection or 0.2% of set measuring distance Whichever is greater.
8	Area Classification	Non-Hazardous/Hazardous as applicable
9	Temperature range	-40°C ... +80°C
10	Display	4 line LCD display. Menu guided operation Display of Envelope curve.
11	Configuration	Using Keypad on display
	Sensor	
12	Range	Liquids 0 to 5m and 0 -10m depending on Tank size
13	Temperature range	-40°C ... +80°C
14	Max Pressure	3 bar abs
15	Materials	Sensor: PVDF Seal: EPDM
16	Process connection	Threaded or universal flange dependent on model selection
17	Degree of protection	IP68

13.14 Float Switches

1) Level switches of the buoyancy type shall consist of a non-mercury switch with changeover action enclosed in a non-corrodible material. A balance weight shall also be incorporated in the switch to counteract the buoyancy effect of the specific gravity of the particular fluid. The connecting cable shall be factory sealed to the switch. The switches shall be installed in a stiller tube in the wells.
2) Level switches shall be installed with a minimum of 3 m of spare connecting cable neatly coiled at a supporting bracket. The connecting cable fixing shall facilitate any alteration in operating level within the limit of the spare cable.

3) The level switches shall act as backup to the level transmitter in the control interlock sequence.

13.15 Sludge Blanket Level Monitor

1) The device shall be used to detect the pressure of sludge or a sludge blanket level.
2) The device shall operate on ultrasonic principles employing two sensors acting as transmitter and receiver. The absorption of the beam by the presence of a sludge or slurry shall initiate a switching action which may be used for control purposes.
3) The device shall be unaffected by vibration, temperature or viscosity of medium being detected.
4) The ultrasonic sensor frequency shall be selected with regard to the medium in which it is to be used.
5) For sludge blanket level detection the sensor shall be suspended/fixed in the tank concerned at the required level. The sensor shall be secured to a corrosion resistant pipe in order to 'steady' the sensor. It shall be possible to adjust the level of the sensor and to remove it easily if required for checking and cleaning.
6) Pipe mounted sludge detectors shall be mounted on opposite sides of a pipe section with the sensor faces flush with the inner pipe surface, in order to promote self-cleaning of the sensor faces by the flow of sludge. The pipe section shall be lined with an epoxy lining or other suitable chemical resistant lining material in order to prevent the build-up of grease in the region of the sensors.
7) The sensors shall operate in conjunction with a converter. The converter shall be provided with the following features:

a) LED sensor status indicators
b) DPCO relay output
c) Internally selectable time delays (typically 0.5 to 30 seconds).

8) The converter shall be provided with sensitivity control typically providing a range of 1: 20.

13.16 Level Gauge (Float & Tape)

1)	Type	:	Float and Tape
2)	Float & Tape MOC	:	AISI 316
3)	Pulley Housing	:	Aluminum
4)	Guide wire	:	SS 316 Stainless steel
5)	Accuracy	:	+/- 2 mm
6)	Indication	:	On circular or vertical dial
7)	Rating	:	Twice the design pressure

13.17 Sight Glass

1)	Type	:	Flap-type
2)	End connection	:	Screwed / Flanged
3)	Material		
	a) Body	:	SS-304
	b) Cover Plate	:	SS-304
	c) Indicator	:	SS-316
4)	Sight Glass	:	Toughened Borosilicate
5)	Gasket	:	Neoprene
6)	Bolts & Nut	:	High tensile steel
7)	Hydraulic Test Pressure	:	1.5 times maximum working pressure
8)	Accessories	:	As required

13.18 Pressure Instrumentation

Pressure Gauges & Pressure Switches:

1) Pressure gauges shall comply with BS EN 837- Parts 1, 2 and 3. Pressure Gauges, Switches & Indicating Transmitters shall have over range protection up to 1.5 times the maximum anticipated line pressure.
2) Internal parts shall be of stainless steel, bronze or other corrosion resistant material.

3) All Pressure Gauges, Switches shall be supplied complete with isolating valves and calibration points to enable calibration or removal without loss of fluid.
4) Where compensation of more than 2% of the instrument span is needed for the difference in level between the instrument and the tapping point, the reading shall be suitably adjusted and the amount of compensation marked upon the dial.
5) Pressure and differential pressure switches shall have contacts with separate 'cut in' and 'cut out' pressure values.
6) The nominal pressure values at which pressure switches operate shall be fully adjustable over the whole range of the instrument and the set value(s) shall be clearly indicated by means of a scale and pointer.
7) Pressure monitoring shall be by a sensor suitable for the medium and pressure/level range.
8) The sensor shall be selected to provide adequate sensitivity over the working range and be capable of sustaining a 400% overpressure without damage. The sensor shall be suitable for either free wire suspension in the medium or fitted remotely and provided with threaded sockets to permit connection of pressure pipe work.
9) A transmitter shall be provided either integral with the transducer or separately mounted and converting the signals received from the transducer to a 4 to 20 mA signal proportional to the range specified.
10) The transmitter shall have provision for span and zero adjustment.

Pressure Transmitters:

Pressure measuring system shall consist of pressure transmitter and digital pressure indicator and any other items required to complete the pressure measuring system. Pressure transmitter shall be rugged in construction and shall be suitable for continuous operation. Pressure transmitters shall be designed for operation over 130% of full range. It should have EEPROM for storing of history data.
Pressure transmitter shall be suitable for field mounting. They shall provide 4-20 mA Current output proportional to pressure. Transmitter output shall be isolated and shall be suitable for transmitting over long distance. Pressure transmitters shall have high degree of weatherproof protection as specified in technical particular. Pressure transmitters shall have LCD display to indicate pressure.

The Contractor shall mark the exact location of pressure measuring point on the pipe line. The contractor shall provide all the hardware items including manifolds, nuts, bolts, pipes, valves, gaskets etc. required for the work.

Sr. No.	Detailed specifications for Pressure Transmitters	
1	Specifications	Pressure Range 0 to 10 /20/50/ 100 Kg/cm2 g
2	Process Temperature range	-20 to +125 deg.C.
3	Output Signal	4 to 20 mA with superimposed digital communication protocol HART 6.0, 2-wire
4	Signal range –	4 to 20 mA HART 3.8 to 20.5 mA
5	Signal on alarm	As per NAMUR NE 43 • 4 to 20 mA HART
6	Resolution	Current output: 1 micro Amp
7	Response time	<250 ms
8	Damping	required
9	Supply voltage	11.5 to 45 V DC
10	Reference accuracy	± 0.1%
11	Housing	Die Cast Alu. Housing
12	Diaphragm Material	Ceramic

Sr. No.	Detailed specifications for Pressure Transmitters	
13	Long Term Stability	± 0.25% URL/year
14	Turn Down	10 : 1

Differential Pressure Transmitter

1	Working Principle	Smart
2	Type	2-Wire
3	Output signal	Superimposed field bus over 4-20 mA DC.
4	Signal Processing Unit	Silicon solid-state electronic circuitry
5	Measuring element	Capsule/ Diaphragm
6	Element material	AISI-316 (Stainless Steel) or better
7	Static Pressure/ Overload Pressure	Maximum line (or static) pressure on either side without permanent deformation or loss of accuracy
8	Turn-down ratio	100 : 1 minimum
9	Span and Zero	Locally adjustable, non-interacting
10	Enclosure class	IP-65
11	Zero suppression / Elevation	At least 100% of Span
12	Output Indicator	LCD type
13	Performance:-	
	• Accuracy	±0.1 % of span or better
	• Repeatability	± 0.05 % of span or better
	• Response time	100 mSec or better
14	Sealing / Isolation	Extended diaphragm with 5 meters SS armoured capillary for viscous fluid applications.
15	Accessories	a) Universal mounting bracket suitable for 2" pipe mounting.
		b) High tensile carbon steel U-bolts.
		c) Companion flange with nuts, bolts and gaskets.
		d) Hand held configurator kit for calibration of Smart Transmitter.
		e) ½" NPT cable gland
		f) ½" NPT generally 5-valve stainless steel manifold, constructed from SS316 bar stock.

13.19 Temperature Instrumentation

Unless otherwise specified, platinum resistance elements shall be used for measuring spans of up to 200°C and chromel-alumel thermocouples for spans exceeding 200°C.

The accuracy for temperature meters shall be ±0.03% of span. Configuration data shall be stored in the EEPROM memory.

In critical and important application, the temperature sensors shall be of a dual type arrangement for easy replacement. Each temperature sensor, unless otherwise specified, shall have a stainless steel thermo well, or pocket-and-extension assembly, non-corrodible metal sheath and waterproof terminal head. Pockets for steam, oil and pressurized-water lines shall be welded; pockets for other duties shall be screwed. The sensor assembly shall be designed to permit removal of the temperature element without twisting the leads.

Platinum resistance thermometers shall comply with BS 1041 and BS EN 60751 or equivalent Indian Standards on the approval of the Employer Representative. Sensors shall have a resistance of 100 ohms at 0°C and shall conform to the European standard curve (DIN 43720), where Alpha = 0.00385. Each element shall be artificially aged during manufacture. Terminal heads and amplifiers shall be designed for four-wire connections between head and amplifier. Platinum resistance elements shall be spring-loaded and fully encapsulated in ceramic material and the elements and high-temperature-resistant lead wires shall be hermetically sealed. The associated resistance-to-current converters shall have zero and span adjustments and input-output circuit isolation.

Thermocouples shall be of the mineral-insulated type and unless otherwise specified shall be of the chromel-alumel (nickel-chromium v nickel-aluminum) type and shall comply with BS 1041 and BS EN 60584-1.

Thermocouple junctions shall be welded. Ceramic-insulation material may be used for base-metal thermocouples but low-silicon insulation material shall be used for noble-metal thermocouples. Thermocouple systems shall have thermoelectric ice point reference chambers or receivers or amplifiers with automatic cold junction compensation.

Thermocouple receivers and amplifiers shall also have zero and span adjustment, common and series mode interference rejection circuits, radio-frequency filters, input-output circuit isolation and thermocouple break feature whereby the output is driven to zero or full-scale, as stipulated by the Employer Representative, when the receiver or amplifier input circuit is broken.

Thermocouple elements shall be electrically isolated from their sheaths but each terminal head shall have facilities for earthing the thermocouple and for terminating the screen of the extension or compensation cable.
Amplifier chassis shall have facilities both for being earthed to the instrument case via a capacitor and for being electrically isolated from the instrument case.

Temperature transmitters shall be of rugged construction microprocessor based instruments. They shall provide simultaneous digital and analogue outputs and the 4mA to 20mA dc output shall be linear with temperature.

13.20 Temperature Switches

Temperature switches shall have contacts with differing ‘cut-in’ and ‘cut-out’ values. Their nominal operating points shall be fully adjustable over the whole range of the instrument and the set-value shall be clearly indicated by a dial and pointer.

Note: - RTD’s of Winding and Bearing Temperatures of Pumps / Motors shall be monitored through Temperature Scanner Indicators.

13.21 Strain-gauge Load Cell Weight Indicator and Transmitters

Weight Indicator Transmitter shall comprise of Compression Type Strain Gauge Load Cells along with Transmitter and Indicator for measurement of Sludge Hopper Weight Applications in Tertiary Treatment Plant. Strain Gauges shall be mounted on the top and bottom to measure Tension and compression forces.

Measuring Range	As per Process Requirement
Temperature Range	-30oc to + 80oc
Accuracy	+/- 0.5 % of Measured Value

Supply Voltage	24 V DC
Output	4-20mA
Indicator Display	Required

13.22 Online Analytical Instrumentation

Online Analytical Instrumentation shall be used to provide continuous monitoring of effluent quality to permit the performance of the Tertiary treatment plant to be assessed on a continuous basis and to provide early warning of plant malfunction or failure. Where appropriate, Online analytical instrumentation shall also be used to monitor functions not related to effluent quality, e.g., digester pH or sludge solids content of sludge for disposal.

The monitors and their associated sensors or cells shall be selected as appropriate to the particular application.

In all cases, the location and housing of the monitor shall take into account the provision of a representative sample to the monitor sensor, the pre-conditioning if any, required prior to the sample's analysis, operator requirements for access, maintenance, calibration, repair and replacement of the monitor or its sensors.

All online analytical instruments shall be single channel and shall have individual analyzer units only.

Note:
Contractor will include the manufacturer's services to perform start-up on instrument to include basic operational training and certification of performance of the instrument.
Contractor will include a manufacturer's Service Agreement that covers all the manufacturer's recommended preventative maintenance, regularly scheduled calibration and any necessary repairs beginning from the time of equipment startup through to SAT acceptance and operation & maintenance period.
The above are to be performed by manufacturer's factory-trained service personnel only. Field service and factory repair by personnel not employed by the manufacturer is not allowed. Manufacturer's service parts and reagents shall be used. Third-party parts and reagents shall not be accepted and used.

Online Turbidity Measurement:

Online sensor shall be based on Nephelometric measuring principle with 90deg scattering light method as per ISO 7027.The sensor shall be of plug and play type with digital communication .The sensor shall be with IP68 rating suitable for measuring range 0 to 9999 FNU /NTU with accuracy of <2% of measured value or 0.1 FNU/NTU.

The sensor shall store on-board all the calibration data and other diagnostic information. On a minimum, the sensor shall have provision to store at-least 5 user calibration points.

The transmitter shall be suitable for outdoor installation with IP67 rating.

	Transmitter	
1	Transmitter Type	Four wire
2	Output	4-20 mA HART current
3	Supply voltage	100 / 115 / 230 V AC +10 / –15%,
4	Material	Field Housing : Polycarbonate
5	Display	LC display, two lines, with status indicators Graphic display : backlit ; transflective display ; user settable measuring menus ; red display for alarms
6	Electromagnetic compatibility	interference emission and interference immunity acc. to

		EN 61326-1:1998
7	Protection class of field housing	IP 67
8	Ambient temperature	–20 ... +60 °C
9	Self-Diagnostic feature	Required
	Sensor	
10	Type	Turbidity
11	Principle	Nephelometric measuring principle 90° NIR scattered light according to ISO 7027 / EN 27027
12	Measuring wavelength and range	860+/- 30nm 0..9999 FNU, 0..150g/l SS
13	Material	Sensor shaft : Stainless Steel 1.4404(AISI 316L) Optical window- Sapphire O-ring- EPDM
14	Max Process temperature	50°C
15	Max Process pressure	10bar
16	temperature sensor	Integrated NTC temperature sensor
17	Connection	Fixed cable connection
18	Ingres protection	IP68
19	Additional Certifications	Required
20	Resolution	0.001 FNU, 0.01 ppm, 0.1 g/l, 0.1%
21	Measurement error	<2% of meas. value (min. 0.02 FNU)

Online pH Measurement:

The p H online analytical instrumentation sensor shall be based on potentiometric measurement using glass sensor. The system shall comprise a combination pH sensor with integral reference electrode and temperature compensation, cabling, sensor mounting and a converter.

Sensors shall be either dip probe, flow cell or insertion types whichever is appropriate.
Dip probes shall be mounted on a floating or fixed corrosion resistant bracket. Insertion type sensors shall be removable without the need to drain down or shut down the process. Mounting of all sensors shall be arranged to prevent fouling and to allow easy access for removal for maintenance, cleaning and calibration.

Where the sensor is likely to be subject to poisoning, e.g. in an anaerobic situation where sulphide may occur, the sensor type shall be selected to be resistant to poisoning, e.g. by the provision of a double junction electrode. The sensor shall function over the pH range 0 to 14.

The system response time shall be not greater than 15 seconds for pH systems used for control and not greater than three minutes for monitoring only systems for 90% change in each case.

Overall accuracy shall be ±0.2 pH with a repeatability of ±0.1 pH. The sensor shall have digital communication based on inductive energy transfer; the sensor shall have inbuilt memory to store calibration data, and other additional diagnostic information. The transmitter shall be suitable for outdoor installation with IP67 rating.

	Transmitter

1	Transmitter type	Four wire
2	Output	4-20 mA HART current
3	Supply voltage	100 / 115 / 230 V AC +10 / –15%,
4	Material	Field Housing : ABS Polycarbonate non corrosive
5	Display	LC display, two lines, with status indicators Graphic display : backlit ; transflective display ; user settable measuring menus ; red display for alarms
6	Electromagnetic compatibility	Interference emission and interference immunity acc. to EN 61326: 1997 / A1: 1998
7	Protection class of field housing	IP 67
8	Ambient temperature	–20 ... +60 °C
9	Diagnostic feature	Required
	Sensor	
10	Type	Glass electrode
11	Principle	Glass electrode Teflon diaphragm
12	Measurement range	0 - 14 pH
13	Material	Glass
14	temperature sensor	NTC / Pt100
15	Connection	Inductive digital connection with Transmitter
16	Ingres protection	IP68
17	Resolution	0.01pH, Temp 0.1°C
18	Calibration	Sensor to store calibration data , min/max pH range , Temperature
19	Measurement Error	± 0.5% of Measuring range

Online Chlorine Measurement:

Online chlorine analyser shall be based on Amperometric based measurement of active chlorine converted to free chlorine by means of pH compensation. The sensor shall have digital communication based on inductive energy transfer which will withstand moisture, corrosion and ensure reliable data transmission at all times.

The offered transmitter shall be IP67, Interference emission & immunity shall be as per EN 61326-1:2006.

	Transmitter	
1	Measuring parameter	Free Chlorine / Residual Chlorine
2	Transmitter type	4- wire
3	No of channel	Two channel (one for chlorine , one for pH)
4	Output	4-20 mA HART current
5	Supply voltage	100 / 115 / 230 V AC +10 / –15%, 48 ... 62 Hz
6	Material	Field Housing : ABS / Polycarbonate
7	Display	LC display, two lines, with status indicators

		Graphic display : backlit ; transflective display ; user settable measuring menus ; red display for alarms
8	Electromagnetic compatibility	Interference emission and interference immunity acc. to ISO EN 61326: 1997 / A1: 1998
9	Protection class of field housing	IP 67
10	Ambient temperature	–20 ... +60 °C
	Sensor	
11	Principle	Amperometric measurement of free chlorine / Residual Chlorine with pH compensation
12	Measurement range	0,01 - 5ppm free chlorine
13	Material	Sensor shaft : PVC
		Membrane : PTFE
		Membrane cap :PBT (GF30); PVDF
14	pH compensation	pH sensor for compensation required
15	temperature sensor	NTC / Pt100
16	Connection	Inductive digital connection with Transmitter
17	Ingres protection	IP68
18	Resolution	0.01mg/l
19	Repeatability	+/- 1 %
20	Measurement Error	1 % of measured value
21	Mounting	Flow assembly

The residual chlorine analyzer shall continually measure the concentration of free chlorine residual present and, by control of the chlorine dosage rate, shall maintain the predetermined concentration. The residual analyzer shall have the capability to initiate high and low alarm locally and to SCADA.

Online Dissolved Oxygen Measurement:

The online dissolved oxygen monitor shall comprise a dissolved oxygen sensor, cabling, sensor mounting and a converter. The sensor shall be provided with a suitable mounting either floating or fixed to locate the sensor in the required position. The mounting shall be specially designed to prevent fouling of the sensor and to permit easy access and removal of the probe for maintenance, cleaning and calibration. Where the sensor is to be sited in a hazardous area, it shall be certified as suitable for use in that area, according to its classification.

The system response time shall be not greater than 40 seconds for control applications and not greater than 3 minutes for monitoring only.

Accuracy shall be 0.01 mg/L or +/- 1% of measured value. This performance shall be maintained without manual intervention for a period of not less than 30 days. Auto calibration or auto cleaning techniques may be utilised to meet this requirement.

If auto cleaning is incorporated it shall not affect the accuracy of the instrument for a period greater than 5 minutes in any hour for a 40 second response system and 15 minutes in any hour for a 3 minute response system.

The converter shall be mains powered and suitable for wall mounting in a local enclosure or for door mounting within an MCC common control section. It shall include a digital display with manual selection of dissolved oxygen as mg/l or % saturation, and temperature in ^{o}C.

The range shall be selected manually. The controller shall include high and low set point control functions and high and low alarm functions. It shall also provide an output suitable for PLC system.

Automatic and manual calibration facilities shall be provided.

Measuring principle	Optical type
Measuring Range	0-20mg/l (0-20ppm)
Temperature compensation	Required
Operating temp range	–5 to 60 °C (20 to 140 °F)
Accuracy	0.01 mg/L or +/- 1% of measured value
Repeatability	+/- 0.5% of measuring range
Sensor material	Sensor shaft : Stainless steel 1.4571 (AISI 316Ti)Cap: POM.Fluorescence layer : Silicone
Temperature compensation	Required , internal
Cable/connector IP rating	IP 68
Sensor signal output	Digital communication with transmitter
Sensor memory	Required to store - calibration data, sensor model, serial number etc
Power Supply	100 to 230Vac +/- 15%, 50/60 Hz
Measuring signal input	Digital input from sensor
Measuring Range	To fit sensor range
Display	Graphic display : backlit ; transflective display ; user settable measuring menus ; red display for alarms
Enclosure IP rating	IP67, NEMA 4X
Enclosure material	Polycarbonate
Electromagnetic Compatibility	Interference emission & immunity as per EN 613261:2006, class A for industry

Online Suspended Solids Measurement

The method of measuring turbidity and suspended solids shall be with a dual-beam infrared/scattered light photometer. Other methods of turbidity and suspended solids measurement, such as four-beam or surface scatter methods, are not acceptable.

A) Performance Requirements
1) Measurement range
a) Turbidity: 0.001 to 4000 NTU
b) Suspended solids: 0.001 mg/l to 50 g/L
2) 2. Accuracy
a) Turbidity: <1% of reading or ±0.001 NTU, whichever is greater
b) Suspended solids: Less than 5% of reading
3) Repeatability
a) Turbidity: Less than 1% of reading

b) Suspended solids: Less than 3% of reading
4) Detection limit
a) Turbidity: 0.001 NTU
b) Suspended solids: 0.001 mg/L
5) Response time: Initial response 1 second
6) Units of measure:
a) Turbidity: User Selectable NTU, FNU, EBC, FTU and TE/F
b) Suspended Solids: User Selectable g/L, mg/L, ppm, or % solids

B) Operational Criteria
1) Sample flow velocity: 3 m/s maximum
2) Sample pressure: 6 bar maximum

The sensor shall provide sample color-independent measurement. The sensor shall be equipped with a self-cleaning device to prevent erroneous values and maintenance problems caused by biological activity, scum build-up, and gas bubbles. The sensor shall measures turbidity and suspended solids.

Online Phosphate Measurement:

Online Phosphate measurement shall be based on Colorimetric principle as Molybdenum blue method as per DIN EN1189 / Molybdate vanadate method. The analyzer shall have auto calibration and auto cleaning facility

Measuring Principle	Colorimetric
Method	Photometric orthophosphate measurement based on Molybdenum blue method as per DIN EN1189 / Molybdate vanadate method
Measurement range	0.05 to 2.5 mg/l PO4-P - Molybdenum blue method
	0.05 to 10 mg/l PO4-P - Molybdenum blue method
	0.5 to 20 mg/l PO4-P – Molybdate yellow method
	0.5 to 50 mg/l PO4-P – Molybdate yellow method
No. of measuring channel	1 channel
Accuracy	+/- 2 % of full scale
Repeatability	+/- 2% of display value +0.01mg/L
Calibration	Auto calibration
Power Supply	115 V AC / 230 V AC, 50/60 Hz
Output	2 X 0/4 ... 20 mA
Enclosure	IP55
Electrical safety and	IEC 61010-1 Class I equipment , Interference immunity as per EN61326-1:2013
Electromagnetic compatibility	Interference immunity as per EN61326-1:2013
Auto cleaning facility	In-built

Online Nitrate Measurement:

Online sensor shall be based on organic substance measurement on absorbance measurement at wavelength at UV254nm.The offered sensor shall not have any sampling or conditioning system, without any chemical requirements

Sensor output shall be in digital format for reliable and long distance transmission without loss of signal due to moisture or water

The transmitter shall be suitable for outdoor installation with IP67 rating.

Measuring principle	Optical sensor based on UV absorption method; measurement at 254 nm without any sampling /conditioning requirements
Sensor type	Direct probe type in-situ mounting without any regent 3for operation
Process temperature	5 - 50°C (41 -120°F)
Absorption wavelength	190-230nm
Reference wavelength	254nm
Process pressure	0.5 to 10 bar (7 to 145 psi) absolute
Ambient temperature	-20 to 60°C / -4 - 140°F
Sensor Ingress Protection rating	IP 68
Maximum measured error	2 % of full scale
Measuring range	0.1 to 50mg/L of NO3-N
	0.01 to 20mg/L of NO3-N
Repeatability	+/- 2 mg/l NO3-N
Drift	Less 0.2 % of end of measuring range per week
Sensor signal output	Digital communication with transmitter
Power Supply	100 to 230Vac +/- 15%, 50/60 Hz
No. of measuring channels	* 1 or 2 channel /Multichannel
Measuring Range	To fit sensor range
Display	Graphic display : backlit ; transflective display ; user settable measuring menus ; red display for alarms
Enclosure IP rating	IP67, NEMA 4X
Electromagnetic Compatibility	Interference emission & immunity as per EN 61326-1:2006, class A

Online TOC Measurement:

Online sensor shall be based on organic substance measurement on absorbance measurement at wavelength at UV254nm, using potassium hydrogen phthalate as organic reference. The offered sensor shall not have any sampling or conditioning system, without any chemical requirements. Sensor output shall be in digital format for reliable and long distance transmission without loss of signal due to moisture or water

The transmitter shall be suitable for outdoor installation with IP67 rating.

Measuring principle	UV photometric - SAC [Spectral absorption coefficient]method; measurement at 254 nm without any sampling /conditioning requirements

Sensor type	Direct probe type in-situ mounting without any regent for operation
Process temperature	5 - 50°C (41 -120°F)
Process pressure	0.5 to 10 bar (7 to 145 psi) absolute
Ambient temperature	-20 to 60°C / -4 - 140°F
Sensor Ingress Protection rating	IP 68
Measuring range	TOC : 0 to 410mg/L
Maximum measured error	2 % of upper end of measuring range
Repeatability	0.5 % of end of measuring range
Drift	Less 0.2 % of end of measuring range per week
Sensor type	Digital sensor communication with transmitter
Chemical	Chemical free measurement
Automatic cleaning	Air cleaning
Power Supply	100 to 230Vac +/- 15%, 50/60 Hz
No. of measuring channels	1 channel
Display	Graphic display : backlit ; transflective display ; user settable measuring menus ; red display for alarms
Enclosure IP rating	IP67, NEMA 4X
Electromagnetic Compatibility	Interference emission & immunity as per EN 61326-1:2006, class A

Online TDS measurement:

Measuring principle	Conductivity
Measuring Range	0.01 - 20 mS/cm
Temperature compensation	Required
Operating temp range	-20 to +135 °C
Pressure range	16bar max
Cable/Cable connector type	Plug in head
Cable/connector IP rating	IP 68
Cable length	15 mtr minimum
Sensor signal output	Digital communication with transmitter
Sensor memory	Required to store - calibration data, sensor model, serial number etc.
Sensor diagnostics	required
Power Supply	100 to 230Vac +/- 15%, 50/60 Hz
No. of measuring channels	1 channel
Measuring Range	To fit sensor range
Enclosure IP rating	IP67, NEMA 4X

Electromagnetic Compatibility	Interference emission & immunity as per EN 61326-1:2006, class A for industry

Online ORP Measurement:

Service	Measurement of Oxidation Reduction Potential
Repeatability	± 20 mV
Range	-2000 – 2000 mV/-1500 to + 1500 mV
Sensor	
Type	Immersion Type
Mounting	Locally
Installation hardware and Integral cable	Required
Probe material Operating temperature range Digital Sensor Pressure range Type of Ground Electrode	Suitable for Tertiary application Analog Sensor: - 5 to 105 deg C - 5 to 70 deg C 0 to 6.9 bar Titanium ground electrode to eliminate ground Loop currents in the measuring electrodes.
Sensitivity	=/- 0.5 mV
Stability	2 mVper 24 Hours, non-cumulative
Flow rate	3 m (10feet) per second maximum
Built in temperature element	NTC 300 ohm thermistor for analyzer temperature Readout
Sensor Cable	4 conductor cable with one shield and polyurethane jacket rated to 105 deg C
Transmitter	
Type	Microprocessor Based having back Lit LCD display
Mounting	Field
Prefabricated integral cable for connecting sensor and transmitter	Required
Analog outputs	4–20 mA

13.23 Auto samplers

Each TTP under this contract shall be provided with an all-weather refrigerated auto sampler's (2 Nos) with all required sample containers (at least 5 nos , comprising of all sizes available), reagents, media (as applicable) for the representative collection of samples to monitor influent and effluent waters individually from the Tertiary treatment plants The auto samplers shall be suitable for indoor and outdoor use. The equipment shall be UL certified.

The method of sample collection shall be via high-speed peristaltic pump for collection of the sample liquid.

Performance Requirements

1) Sample cooling: maintain sample liquid at 4°C (39°F) in ambient temperature to 50°C (122°F) maximum; accurate to ±0.8°C (±1.5°F).

2) Sample volume: shall be programmable in 10 mL increments from 10 to 10,000 mL.
3) Sample volume repeatability ±5% of 200 mL sample volume with: 4.6 m (15 ft.) vertical lift,
4) Sample volume accuracy: ±5% of 200 mL sample volume with: 4.6 m (15 ft.) vertical lift
   Operational Criteria
5) Operating temperature: 0 to 50°C
6) Storage temperature: -30 to 60°C

The auto samplers shall be interfaced with the plant main PLC system for complete monitoring of the auto sampler system parameters, control & monitoring from the PLC system.

13.24 Laboratory Instruments

The laboratory shall be equipped with Lab instruments, equipment, chemicals and other infrastructure that is necessary to perform the routine analysis for the parameters as detailed in table below.

TTP Contractor shall submit the complete list of lab equipment required for full analysis of parameters to the employer's representative for approval. Contractor shall include in his offer supply of chemicals required for analysis along with proposed lab instruments and associated equipment, including for the O&M period as specified elsewhere in the bid document.

Minimum list Laboratory equipment to be provided are detailed as below:

Item No	Description	Unit	Quantity
1	Comparator test set for residual chlorine or chloroscope	No.	1
2	Multi Parameter (pH and Conductivity Meter)	No.	1
3	Mains operated pH meter completed with one calomel electrode and glass electrode	No.	1
4	Turbidimeter - Bench Model (Nephelometric Type)	No.	1
5	Turbidimeter - Hand held (Portable)	No.	1
6	Spectrophotometer	No.	1
7	Water bath with 6 to 8 concentric holes and discs, electrically heated	No.	1
8	Soxhlet extraction unit	No.	1
9	Kjeldahl digestion unit	No.	1
10	Hot plates	No.	10
11	Distilled water plant	No.	1
12	Demineraliser	No.	1
13	Refrigerator (320 litres capacity) double door	No.	1
14	B.O.D. incubator	No.	1
15	Muffle furnace	No.	1
16	Electric oven	No.	1
17	Magnetic stirrer	No.	1
18	Monopan balance with digital display	No.	1
19	Jar-Test apparatus with RPM controller and simultaneous addition of Chemicals in all jars	No.	1

Item No	Description	Unit	Quantity
20	Centrifuge	No.	1
21	Gas cylinder if gas supply is not available	No.	1
22	Fume cupboard/hood	No.	2
23	Field Test kit for cations and anions	No.	2
24	Depth sampler	No.	2
25	Online Total organic carbon analytical analyser with online feedback to SCADA system	No.	1
26	Sieve shaker with standard sieves and Two pan balance, weighing up to 200gm samples	No.	1
27	Electronic Weighing Balance (Max. 10 kg)	No.	1
28	Durham tubes and Imhoff cones (1 lot)	lot	1
29	D.O meter	No.	1
30	Specific Gravity Meter (1.0~1.1 and 1.2~1.3)	No.	1
31	Consumables – disposable & reusable type	No.	1
Equipment Needed For Bacteriological Examination			
30	Hot Air Oven	No.	1
31	Autoclave	No.	1
32	Incubator 37°C or 44°C (Water/Air-Jacketed)	No.	1
33	Binocular microscope	No.	1
34	Digital pH Meter	No.	1
35	Pipette Box (Stainless Steel)	No.	10
36	Wooden Racks/Aluminum Racks	No.	5
37	Wire Baskets	No.	10
38	Cotton/ Aluminum Foils	No.	10
39	Burners (Bunsen) With Pilot Lamp	No.	3
40	Suction Flask (1 Litre Cap)	No.	2
41	Suction Pump	No.	1
42	Sampling Bottles	No.	10
43	Measuring Cylinders (1000 Ml, 500 Ml, 200 Ml, 100 Ml, 50 Ml, 25 Ml)	Set	3
44	Vacuum pump	No.	1
Bacteriological Media			
45	M. Endo Broth (dehydrated)	No.	1
46	Lactose or Lauryl Tryptose broth	No.	1
47	Mac Conkey broth	No.	1
48	Brilliant Green Bile Lactose Broth	No.	1
49	Total Plate Count Agar	No.	1

Item No	Description	Unit	Quantity
50	Peptone/Triyptone Water	No.	1
51	Laminar Air Flow Chamber	No.	1

The above indicated lab instruments are the minimum equipment to be provided at each TTP. If as per process requirements, any additional equipment is required, the contractor shall supply the same at no additional cost.

The equipment shall be supplied with all the accessories that are necessary to make the equipment functional for analyzing parameters. Contractor shall include any additional equipment if necessary under his scope of work.

UV Visible Pre-programmed Spectrophotometer:

UV Visible Pre-programmed Spectrophotometer for measurements of water Quality parameters and Spectral Analysis Shall be pre-programmed for more than 200 preprogrammed tests and special methods, 100 user defined methods, concentration, absorbance, transmission, factor, kinetics, 2-point calibration, scan, nephelometric turbidity measurement, different color measurement scales common drinking water testing parameters like residual chlorine, Iron, Hardness, alkalinity, fluoride and sulfate etc. The spectrophotometer instrument shall be a multi-wavelength, UV-Visible, single beam spectrophotometer designed for Water analysis. The instrument, depending on the test selection, shall automatically select the wavelength.

Readout modes shall include transmittance, absorbance, concentration, optional wavelength scan and time course graphs. Spectrophotometer should come along with the following reagents and accessories**:** Power supply, Operators manual, one pair 10mm rectangular path length cells and reagents for common drinking water parameters like residual free chlorine, Iron, sulfate, silica Low range and Fluoride for 1000 tests.

Technical Specifications:

Technical specifications of UV-Visible spectrophotometer	
Type:	Spectrophotometer with reference detector technology (RDT)
Light sources:	Halogen lamp (visible range) Deuterium lamp (UV range)
Optical system:	Monochromator
Wavelength range:	190 nm–1100 nm
Wavelength accuracy:	± 1 nm
Wavelength resolution:	0.1 nm
Wavelength calibration:	Automatic ,Instrument should have inbuilt Holmium oxide filter
Wavelength selection:	Automatic, barcode, manual
Scan speed:	1 complete scan < 1 min
Spectral bandwidth:	< 2 nm
Photometric range:	± 3 Abs
Photometric accuracy:	0.005 Abs at 0.0–0.5 Abs; <1% at 0.5–2.0 Abs
Photometric linearity:	< 0.5% at 2 Abs; <1% at >2 Abs
Stray light:	< 0.05 %
Measuring modes:	More than 200 preprogrammed tests and special methods, 100 user defined methods, concentration, absorbance, transmission, factor, kinetics, 2-point calibration, scan, nephelometric turbidity measurement, different color measurement scales
Turbidity	Nephelometric turbidity measurement, 0.1–1000 NTU, instrument

measurement:	should have separate optics for turbidity measurement. Turbidity must be measured and shown for preprogrammed tube tests and customized methods in tubes and shown together with the result of the measurement to account for interfering turbidities (nephelometirc turbidity)
Preprogrammed special methods	Measurement of nitrate and SAC in UV range; nephelometric turbidity and TSS
Inspections equipment monitoring (IQC)	Instrument must have a preinstalled Holmium oxide filter to automatically check for wavelength accuracy. Control of lamps, photometric correctness and stray light. Measurement of standards, spike additions, multi determinations and dilutions
Color measurements	CIE conform color measurements must be possible, Measurement of color according to ISO7887 B,C ,APHA/HAZEN/PT-CO, ASTM 209,GARDNER,SAYBOLT (ASTM D156 ASTM 6045),Hunterlab, ASTM D1500,ICUMSA ,EP (Phr Eur) ,mgl2,Hess-Lves and Spectral data
User programs	100
Cuvette slot:	Universal cuvette slot for: Test tubes 16 mm OD Rectangular cuvettes 2 mm, 10 mm, 20 mm, 40 mm and 50 mm
Data memory:	Internal Micro SDHC card, 5000 measured data sets, 100 spectra, GLP conform (result, date, time, operator, dilution, comment, sample ID)
Display	HD 10 inch, anti-reflective cover glass with projected capacitive touch screen (PCAP)
Operating range:	10–40 °C, max. 80 % relative humidity (without condensation)

Laboratory pH Meter:

pH meter Technical Specifications	
Measurement Method	pH : Glass electrode method Temperature: Thermistor resistor
Display unit	Large Screen display Various display functions: Vertical/Horizontal screen switchable Graphic Display Easy-to-read menu Touch panel input Maintenance information
Measurement Item/Range	pH:0.000 - 14.000 Temperature: 0.0 - 100.0°C
Display Range	pH: pH-2.000 - 16.000 Temperature: -5 - 110.0°C
Display resolution switch	pH: 0.01pH/0.001pH mV (ORP): 1mV
Repeatability(Main body)	pH: ±0.006pH mV(ORP): ±2mV Temperature: within ±0.2°C
pH Temperature	ATC(Auto Temperature Compensating): 0 - 100.0 °C

Compensation Range:	MTC(Manual Temperature Compensating):0 - 100.0°C
pH Calibration:	JIS pH standard solution, US standard solution, customized standard solution, Max. 5 point calibration
Temperature Calibration	1 point calibration
Performance Guaranteed Temperature, Humidity	0 - 45°C, 20 - 85% or below(condensation-free)
Auto Hold Function Facility	Instrument should have auto hold function
Calibration History Creation Function	Latest one run
Interval measurement	Required

Bench top Multi parameter meter:

A multi parameter instrument capable of analysis of pH, ORP, dissolved oxygen, conductivity, TDS, salinity and temperature shall be provided. The instrument shall be capable of a quick response and have an intuitive user interface. The instrument shall have automatic temperature correction/compensation. Downloading and storage of data should be easy and convenient. It shall provide RS-232 interface and shall have a minimum of 150 points recall feature.

Technical Specifications:

Multi-Function Water Quality Technical Specifications	
Measuring method:	pH: Glass Electrode Method ORP :Platinum Electrode Ion :Ion Electrode Method Conductivity: AC 2-Electrode Method DO : Diaphram Polarographic Method Temperature : Thermistor Resistor
Conductivity Measuring Frequency	80Hz/3kHz, automatic selection
Electrode Inputs	2ch (pH/ORP/Ion/DO Electrode/Conductivity cell connectable)
Display Unit	Touch Panel Color Graphic LCD
Display	Selectable 2-ch Simultaneous Display or Single Only Display
Measuring Range	pH:0.000-14.000pH mV（ORP）: -2000.0~2000.0 mV Ion: Depends on the sensor Conductivity: Depends on the cell Resistivity: Conversion from conductivity Depend on the cell Salinity: Conversion from conductivity Concentration: Conversion from conductivity TDS: Conversion from conductivity DO: Depends on the electrode Saturation %: Depends on the electrode
Temperature:	0.0~100.0°C DO:0.0~50.0°C Ion: Depends on the sensor (No temperature compensation function)
Display Range	pH: -2.000-16.000 Temperature: -5-110.0°C
Repeatability(main unit):	
pH	±0.02pH

mV(ORP)	-2200.0~2200.0 mV
Ion(Manual/Auto range switching) (mol/L selectable):	ZOOM OFF 0.0 ～ 19.9μg/L, 20 ～ 199μg/L, 0.20 ～ 1.99mg/L, 2.0 ～ 19.9mg/L, 20 ～ 199mg/L, 0.20 ～ 1.99g/L, 2.0 ～ 19.9g/L, 20 ～ 199g/L, 200 ～ 1990g/L ZOOM ON 0.00 ～ 19.99μg/L, 20.0 ～ 199.9μg/L, 0.200 ～ 1.999mg/L, 2.00 ～ 19.99mg/L, 20.0 ～ 199.9mg/L, 0.200 ～ 1.999g/L, 2.00 ～ 19.99g/L, 20.0 ～ 199.9g/L, 200 ～ 1999g/L
Conductivity(Manual/Auto range switching):	0.0 ～200.0μS/m （ 0.000 ～2.000μS/cm） 0.000 ～2.000mS/m （ 0.00 ～20.00μS/cm） 0.00 ～20.00mS/m （ 0.0 ～200.0μS/cm） 0.0 ～200.0mS/m （ 0.000 ～2.000mS/cm） 0.000 ～2.000S/m （ 0.00 ～20.00mS/cm） 0.00 ～20.00S/m （ 0.0 ～200.0mS/cm） 0.0 ～200.0S/m （ 0.000 ～2.000S/cm） SI unit (S/m) and conventional unit (S/cm) selectable
Resistivity(Manual/Auto range switching):	0.005 ～2.000 Ω·m（ 0.5 ～200.0Ω·cm） 0.00 ～20.00 Ω·m（ 0.000 ～2.000kΩ·cm） 00.0 ～200.0 Ω·m（ 0.00 ～20.00kΩ·cm） 0.000 ～2.000kΩ·m（ 0.0 ～200.0kΩ·cm） 0.00 ～20.00kΩ·m（ 0.000 ～2.000MΩ·cm） 00.0 ～200.0kΩ·m（ 0.00 ～20.00MΩ·cm） 0.000 ～2.000MΩ·m（ 0.0 ～200.0MΩ·cm） 0.00 ～20.00MΩ·m（ 0 ～2000MΩ·cm） SI unit (Ω·m) and conventional unit (Ω·cm) selectable
Salinity:	0.00 ～ 4.04%（ NaCl） 0.00 ～ 42.40psu (PSS: Sea water salinity)
Concentration(Auto range switch):	0 ～ 2.000%, 0 ～ 20.00%, 0 ～ 200.0%
TDS(Manual/Auto range switching):	0 ～ 99.99mg/L, 0 ～ 999.9mg/L, 0 ～ 9.999g/L, 0 ～ 99.99g/L, 0 ～ 999.9g/L
Dissolved Oxygen:	0.00 ～ 22.00mg/L (High range membrane set (Option) 0.00 ～ 55.0mg/L)
Saturation %:	0 ～ 220.0% (High range membrane set (Option) 0 ～ 550%)
Temperature:	-5.0 ～ 110.0°C
Display Resolution Switching:	pH: 0.01pH/0.001pH mV: (ORP) 1mV/0.1mV Ion: 0.0μg/L～1990g/L (Maximum to 3 digits) 0.00μg/L～ 1999g/L (Maximum 4 digits)
Repeatability(Main body unit):	pH: ±0.002pH mV(ORP): ±0.2mV Ion: ±0.5% FS Conductivity: ±0.5% FS

	Resistivity: ±0.5% FS Salinity: ±0.5% FS Concentration: ±0.5% FS TDS: ±0.5% FS Dissolved Oxygen: ±0.03mg/L (Standard membrane)/±0.1mg/L (High range membrane) Saturation %: ±1% (Standard membrane/High range membrane) Temperature :within ±0.2
Temperature compensation:	pH Temp. compensation range: ATC（ Auto Temperature Compensation）: 0 ～100.0°C MTC(Manual Temperature Compensation): 0 ～100.0°C Conductivity Temp. compensation Range: ATC(Auto Temperature Compensation): 0- ～100.0°C MTC(Manual Temperature Compensation):0 ～100.0°C Dissolved Oxygen Temperature Compensation Range : ATC(Auto Temperature Compensation): 0 ～ 50.0°C
pH calibration	JIS pH Standard Solution, US Standard Solution,Custom Standard Solution, Max. 5-point Calibration
Ion calibration	Max.5-point Calibration
DO calibration	Auto Calibration（ Zero Span Calibration）
Temp. calibration:	1-point Calibration
Conductivity Concentration Conversion Setting:	2-10 points
Data Memory:	2000 data each channel
Analog Output:	pH:±700mV (pH0 ～ 14) mV(ORP): ±1V(0 ～ ±2000mV) Ion: 0 ～ 1VFS Conductivity/Resistivity/Salinity/Concentration/ TDS: 0 ～ 1VFS DO/Saturation: 0 ～ 1VFS Range(Ion/Conductivity/Resistivity/Salinity/ Concentration/TDS):100mV/Range Temperature: 0 ～1V(0 ～100°C)

Laboratory Turbidity Meter:

Turbidity meter shall have pre-programmed features for measurement of turbidity with ratio color correction covering the range from 0 to 10,000 NTU with auto signal averaging. Turbidity meter should come along with the following accessories: A complete set of calibration standards (0.02, 10, 100, 1750 NTU), Two measuring corvettes with light shield caps, operators' manual, and plug in power adaptor.

Technical specifications:

1	Principal of operation	Nephelometric
2	Light Source	Infra-red
3	Extended auto ranging	up to 10,000 NTU 0 - 2,450 EBC

		0 - 10,000 FNU 0 - 10,000 FAU
4	Resolution	NTU on lowest range
5	Accuracy	± 2% to ±10% of reading (in 3 ranges)
6	Response time	less than 6 seconds
7	Sample size	30 ml
8	Air purge	connection for external dry air supply
9	Auto alert calibration prompt.	
10	Outputs	RS-232 Serial Port
11	Reusable Calibration Standards	
12	Certification	UL, CSA, CE, ISO7027

Instrument should have option for connecting flow thru cell.

Portable Turbidimeter

The integrated algorithm of scattering and transmission not only makes the measurement of low turbidity more stable, but also realizes wide testing ranges for the instrument (low, middle and high measuring ranges. Integrating algorithm of Scattering(90°) and transmission

Technical Specifications:

Ranges	0-1000NTU
Accuracy	±5%
Drifting	≤±1.5%
Repeatability	≤1%
Resolution	0.01NTU (0-9.99NTU) 0.1NTU (10-99.99NTU) 1NTU (100-1000NTU)
Stray Light	< 0.02 NTU
Sample required	15 ml
Detector Silicon	photodiode
Storage conditions	-25 to 50 °C（instrument）
Operating conditions	0 to 50 °C; 0 to 90% relative humidity (noncondensing)

Dissolved Oxygen Meter:

Technical Specifications:

Range	:	0.00 ～ 22.00mg/L
Repeatability	:	±0.03mg/L (Standard membrane
Resolution	:	Temperature :within ±0.2
Method	:	Membrane Polarographic

Salinity range	:	0.00 ～ 4.04%（NaCl） 0.00 ～ 42.40psu (PSS: Sea water salinity)
DO/Saturation	:	0 ~1VFS
Dissolved Oxygen Temperature Compensation Range	:	ATC(Auto Temperature Compensation): 0 ～ 50.0°C

Residual Chlorine Meter:

The instrument should be a handy model which should be capable of analyzing three water quality tests. Instrument should be simple to use and should display error messages as and when they occur. The instrument should be pre-programmed to conduct the following tests:

Type:	LED photometer with 3 interference filters
Wavelengths:	450 nm, 530 nm, 590 nm
Wavelength accuracy:	± 2 nm, bandwidth at half transmission 10–12 nm
Measuring modes:	Pre-programmed tests
Cuvette holder:	Tubes 16 mm OD
Memory:	50 results
Display:	Backlit graphic display, result with unit
Operation:	Self-explanatory menu guidance, plastic foil keypad test selection via parameter lists
Power supply:	3 AA batteries, rechargeable batteries, USB interface; optional internal accu-pack
Preprogrammed Methods	chlorine, chlorine dioxide, pH, fluoride and iron
Supply	DPD Chlorine reagent for 100 test

In addition, Instrument should include the following**:** Intransclam packing with reagents for 100 free chlorine tests**,** Crushing rod and 2 test cells. The instrument should be provided with a operations &instructions manual.

Portable Density Meter:

Type : truly portable measurement, visibility: both indoors and outdoors to be achieved.
Accuracy : ± 0.001 or better
Storage Capacity : above 1000 results.
Multiple sequential measurements shall be possible with the meter. Meter's sample tube is to be dipped directly into the sample for measurement.
Meter shall be Battery Operated; Lithium ion Rechargeable and removable type batteries shall be used. Temperature Compensation shall be an automatic or by using a user-defined temperature correction coefficient.
If required, meter shall have built-in sampling pump and interface to PC for data acquisition & logging,

13.25 Associated Lab Equipment:

Sterilizer, Autoclave:

Purpose: For sterilization of glassware and culture media for bacteriological analysis.

Double wall construction with inner & outer chamber made of Aluminum. Electrically heated by means of superior quality emersion heaters with working pressure 15 PSI. Inner Chamber Size: 550X750mm. Rating: 6.0 KW, Volume: 175litre.

Balance, Analytical (Electronic):

Purpose: For preparation of standard solutions used in chemical analysis.

Specifications: Should be based on E.M.F.C. Technology

Type: Electronic single Pan, Capacity: 200 mg, Resolution: 0.1 mg, Stainless steel weighing pan; Pan Size: 100 mm Diameter, Display: Sharp, Clear LED Display and Standard bi-directional RS232C interfaces. Multiple weighing Units: Grams & Carat. It should have auto calibration facility, Overload protection and auto zero facility. Balance should come along with Set of certified calibration weights, Voltage stabilizer, Dust proof cover, Operational manual and necessary tools.

Centrifuge: Purpose: For separation of suspended matter from suspensions.

Specifications:

Max. Speed	20000 RPM, Max. RCF: 34500, Max. Tube size: 100 ml, Max. Capacity: 400 ml. Width: 450 mm, Depth: 470 mm, Weight: 35 kg
Connected Load	0.75
Rotor Angle Head	8x50 ml
Speed regulation	Step less variable speed control.
Digital Speed indicator	1 to 99 minutes digital timer with by-pass switch for infinite time run.

Incubator Bacteriological:

Purpose: For incubation in bacteriological analysis

Double walled cabinet. Outer wall should be made of mild steel, inner wall of stainless steel, lagged with a special insulating material. The inside door should be made of glass panel set in a metal frame fitted with a felt gasket and be fastened by a ball catch.

Temperature range	°C above ambient to maximum 60°C.
Accuracy	±2°C
Size	600X600X600cm
Rating	1000Watts.
Purpose	For cooling and storage of (standard) solution in a laboratory

Specifications:	
Type	Vertical double door
Capacity	Approx: 280 litre.

Water Bath, General Purpose:

Purpose: For enhancement of chemical reaction in various analyses and evaporating of water from samples

Specifications: Doubled walled construction Fitted with imported thermostat of 30 Deg C to 110 °C Accuracy of +/- 1 DegC.Working Temp. from 5 Deg C above ambient 80 °C made of double wall, stainless steel construction, with glass wool
Capacity: 15 Ltrs

12 holes of 75 mm dia , 2000 Watts

Ware Purifier, Distillation Unit (Automatic)

Purpose:

Applications Type III water maker
Instrumental Analysis & reagent preparation
Feed Water Specifications
TDS : 500 PPM MAX
Fe ,Mn : NIL
Free Chlorine : NIL
Silica : <20 PPM
Inlet Pressure : 0.5 – 2.0 kg/cm
Product Water Specification:
Nominal Flow To Storage Tank:10 Ltr/Hr
Pure Water Resistivity (Tpye II) : >1 MD
Pure Water Conductivity(Tpye II) :1 µS/cm
Turbidity: 1 NTU
Total Organic Carbon (TOC) : <200 ppb

Rectangular heating Plate with cast Iron top

Shall be used for continuous heating up to 350ºC. The body shall be of made of P.C.R sheet painted. Attractively with good stove enamel Top rectangular cast iron Plate has insulated elements. To work on 220/230V AC supply
Size (L x B x H):25 x 30 x 15 cm (10”x12”x6”), With E/R

Water Still Automatic (Wall Type)
Compete made of S. Steel provided with automatic ejection type emersion heaters to provide pyrogan free water
Capacity: 4 Liters, Load: 4 KW

Demineraliser
Two Bed Capacity 100 lt/hr

Refrigerator--Double Door

Capacity: 280 Liters

Muffle Furnace Rectangular

Light weight with ceramic fibre wool insulation the outer casting shall be made of double walled thick P.C.R.C. sheet Re attached with thick perforated sheet on the bottom portion, painted with attractive stove enamel.

Heating elements shall be made of KANTHAL A1 wire of coil form embedded on the muffle with high grade refectory cement and backed by high temperature cer-wool insulation which avoids loss of energy. The apparatus shall be complete with one pyrometer, thermocouple & silver thermal fuse.

Laboratory Oven

Double walled construction. Inner chamber made of Aluminum/ S. Steel. Outer body made of mild steel is powder coated/painted. Temperature shall controlled by Microprocessor based PID Controller from 50-250C .Provided with

air circulating fan. The gap between the inner & outer chamber is filled with high grade glass wool to avoid the thermal losses. Perforated adjustable trays. Two pilot lamp on/off switch. To work on 220/230 V.AC.
Size: 45x45x45cms

Magnetic Stirrer
With Hot Plate, Capacity: 2 liter

Jar Testing or Multiple Spindle Stirrer
This unit is designed for flock information fest in water treatment plants with variable speed from 25 to 150 RPM 1/20 H.P. geared motor whole unit is mounted on mild steel housing with tube lights support by four support or 9½" height. S. Steel stirring peddle 1/3" are attached to rods 10" long ¼" dia motor with lifting knob at the top. Locking collars at stirring rods permits adjustments of paddle height spacing of 6" between rods, permits use of 1000 ml beakers arresting directly on bench. Complete with ON/OFF switch.

Mini Gas Cylinder with Regulator

Fume Hood
Thick wooden board fabricated, outer is finished with Laminated Mica and inner duly painted, designed so as throw out all toxic/charmful vapors, thus protecting costly instruments and the person working in the lab. Working table top is fitted with stainless steel top, provided with SS sink and Tap. The front door moves vertically up & down with concealed counter balanced weight/by Hingers the unit is fitted with fluorescent light and a gas cock for gas/air supply. The space under the work station can be provided with switches for exhaust system and b fluorescent lights. Workable on 220 Volts AC supply.
Working Size: 4'x2'x2'.

EQUIPMENT NEEDED FOR BACTEROLOGICAL EXAMINATION

Hot Air Oven
Double walled construction .Inner chamber made of S.Steel. Outer body made of mild steel is powder coated/painted Temperature thermostatically controlled by hydraulic thermostat from 50°C to 250°C Elements are at the bottom and sides. Built in 'L' shape thermometer the gap between the inner & outer chamber is filled with high grade glass wool to avoid the thermal losses. Perforated adjustable trays. Two pilot lamp on/off switch. To work on 220/230 VAC Size: 350x350x350mm (14"x14"x14").

Autoclave Vertical
Outer body made of thick mild steel finished oven baked enamel Inner chamber will be thick stainless steel. The chamber is absolutely leak-proof and it can be operated at any selective point in between5 to 20 pound/Sq. inch The instrument is equipped with pressure gauge Pressure release valve, safety valve, water level indicator and perforated S.S. basket complete with cord and plug The lid is made of thick mild steel sheet duly lined with stainless steel with pedal lifting arrangements and radial locking devices to work on 220/230V AC single phase supply Inner Chamber Dia x Depth:300 x 500 mm,Load:2.0KW.

Incubator 37°C or 44°C (Water/Air-Jacketed)
Triple walled construction. Inner chamber made of Aluminum/ S. Steel. Outer body made of mild steel is powder coated/painted. Temperature is controlled by Microprocessor based PID Controller from Ambient + 5 to 60X.Provided with air circulating fan . The gap between the inner & outer chamber is filled with high grade glass wool to avoid the thermal losses. Perforated adjustable trays. Two pilot lamp on/off switch. To work on 220/230 V.AC.

Binocular microscope
Binocular Microscope : With quadruple revolving ball bearing nosepiece , low drive Co-axial mechanical stage, binocular head with hard coated prisms, graduated precise slow motion, with built in light arrangement having 6v-20w halogen lamp and solid state light control arrangement complete in box with following optics Eye pieces WF10 x & H 5x (Three pairs) 3 pairs Objectives 4x, 10x, 40x (SL), 100x (SL) oil.

Pipette Box (Stainless Steel)

Aluminum Racks 18mm, 12 holes

Wire Baskets Size: 140x120x110mm

Aluminum Foils (roll of 9 mtr.)

Burners with pilot lamp

Suction Flask (1 Litre Cap)

Suction Pump

Promivac`100% Oil free Diaphragm/Piston type Vacuum-Pressure pump, portable, single/double head, complete in all respect as per following specifications.
Type : Diaphragm
Head : Double
Displacement: 45 liters. /Min
Vacuum : 27"Hg. (100 mbar)
Pressure : 55 psi
H.P. : ¼, single phase, 220-240 V
Vacuum gauge with Regulator

Sampling Bottles

Measuring Cylinders (1000 Ml, 500 Ml, 200 Ml, 100 Ml, 50 Ml, 25 Ml)

Vacuum pump

100% Oil free Diaphragm/Piston type Vacuum-Pressure pump, portable, single/double head, complete in all respect as per following specifications
Type : Diaphragm
Head : Double
Displacement: 45 liters. /Min
Vacuum : 27"Hg. (100 mbar)
Pressure : 55 psi
H.P. : ¼, single phase, 220-240 V
Vacuum gauge with Regulator

Laminar Air Flow Cabinet

Laminar air flow cabinets able to create particle free air of Class-II standard. The cabinet is fabricated out of board with sunmica laminated exterior. The working table is made of thick board which is also sunmica at top. Laminar flow is based on principle of double filtration of air. Atmospheric air will be drawn through the pre-filters by heavy duty blowers. Filtered air than passed through highly effective HEPA Filters with 99.97% efficiency for particulates of 0.3 micron or larger, which can filter almost all air born contaminants such as dust, fungal spores, bacteria etc. Double filtered laminar flow air will blow horizontally/vertically through the working table at a nominal velocity or approx 90 Fts/min. Heavy duty blowers dynamically balanced with 0.25 HP electric motor are mounted on shock resistant base of cabinet or anti-vibration pads, operate on 230 +/- 10 volts, 50 Hz AC supply. Shadow less uniform lighting is provided within working space (100 feet candles). Unit will be mounted on caster wheel and supplied with high quality plug and cord
Size: 3 x 2' x 2

FURNITURE

The laboratory furniture shall be modular in design, made of mainly 18 SWG CRCA/GI Sheet in panel form to get the best and full coverage of powder coating and in CKD – Completely Knocked Down construction so can be

installed at site as per approved layout. Laboratory Modular Furniture includes Pedestal Frame Structure, Under Bench Storage Modules and Work Top / Surface.

The furniture shall be designed of height 900mm for standing posture and 750mm for sitting posture. Height will be maintained as per the site requirement. All metal components / parts shall be 7tanks pre-treated (with premium chemicals and DM water) and 50-60 micron Epoxy Polyester Coated with automatic robotic spray gun.

1. WALL BENCH – 1 (20 SWG CRCA/GI sheet with PU powder coated)

Overall Dimensions L=6000m,W=750mm,H=900mm

It consists of following.

Base Cabinet L=600mm 1 drawer 2 shutter – 10 No's

Base Cabinet L=600mm 2 shutter – 10 No's

Granite Top L=6000mm W=750mm – 1 No

PP Sink – 2 No's

Three way water tap – 2 No's

Electrical raceway - 5+10

2. WORKING TABLE – 1 (20 SWG CRCA/GI sheet with PU powder coated)

Overall Dimensions L=1200m,W=750mm,H=750mm

Shall consists of following.

Base Cabinet L=600mm 1 drawer 2 shutter – 1 No

Foot rest L=600mm – 1 No

Granite Top L=1200mm W=750mm – 1 No

3. Revolving Stools

4. Revolving Chairs

5. Almirah for Storage

6. White-board & pens

Work Tables and Benches

Minimum of 1set of work table and chair per staff shall be provided for the laboratory and office staff. The furniture and chairs shall be of ergonomic design. This work table shall be isolated within a Laboratory to form a cabin with a glass partition.

The work tables shall be along the wall and shall be provided with adequate storage capacity and open glass shelves on the top to provide additional space for storage of chemicals and stock solutions.

A fume cupboard with ventilation hood shall be provided to prevent spreading of toxic and irritant fumes and odours into other parts of the laboratory. Forced ventilation with exhaust fans shall be provided. The wall space and offsets shall be convenient to locate cabinet, benches, hoods, incubators alongside without any loss of floor space.

Contractor shall also provide Almira for document storage purpose

Contractor shall also provide almirah with lock facility for document storage purpose. Separate cabinet shall be provided for storage of PPEs, Lab coats etc.

Consumables for Laboratories

Consumables must be replaced regularly because they wear out or are used up. Lab Consumables maybe disposable and reusable.

Contractor shall supply sufficient quantity of consumables required during testing & commissioning period as well as during entire Operation & maintenance period of contract.

The consumable includes but not limited to litmus papers, bags, Labels & markers, cleaners, bottles & caps, Gloves, Tapes, Lab containers, dishes, knives & cutters, gloves, glassware, funnels, flasks, Scalpels, Scissors & Shears, Tongs, Timers, stoppers-counters, films & foils, beakers, Pipettes, Pipettors & Tips, Crucibles, Forceps and Tweezers, white board pens, permanent markers & most importantly Reagents & chemicals, gas Cylinders etc.

Laboratory Waste Disposal Procedures. Waste disposal shall be managed by the appropriate party and it typically includes the following categories: municipal waste, hazardous waste, biological waste and sharps.

Chemical Laboratory safety measures

Personal protective equipment and safety devices must be provided to all employees under the appropriate circumstances and employees have the responsibility of properly using such equipment. According to safety regulations, it is obligatory to wear a lab coat and closed shoes in the lab, safety glasses and gloves if necessary.

Laboratories may contain certain inherent dangers and hazards Laboratories shall also be well equipped with all sort of safety measures which shall include Fire extinguishers, First Aid Box, provision for eye wash, Safety sign-boards, warning etc.

Labels and warning signs should alert employees to potentially hazardous materials and allow those unfamiliar with the laboratory surroundings to identify hazardous chemical use and storage areas, safety facilities, emergency equipment and exits and aid emergency response personnel.

13.26 Online Real Time Multi Parameters Continuous Monitoring System for Influent and Treated Tertiary Parameters for the TTP's

The online real time multi parameter continuous monitoring system (2 Nos, one at inlet and one at outlet shall be provided for each TTP) shall be able to measure the below indicated parameters on a minimum through extractive method only for ease of operation, calibration & troubleshooting and shall have the capacity for future expansion.

On a minimum the following parameters shall be measured at the plant inlet and outlet: COD, BOD, pH, TSS,TOC, Ammonical-Nitrogen, Total Nitrogen, Dissolved Oxygen, Color & Temperature measurement at the inlet and outlet of the each TTP

The system shall have capability to accommodate any additional parameters viz. Turbidity, Conductivity, TDS, Oil in water, etc. as may be required by the end user, from time to time.

The contractor shall provide complete analyzer with the Sample handling system. The required Pump, Sample Tubing & other necessary accessories shall be in the contractor scope of work.

The online real time multi parameter continuous monitoring system shall be equipped with inbuilt automatic cleaning facility. Required mechanism & cleaning solution for automatic cleaning shall be supplied for the entire duration of the operation and maintenance period. For the air-pressure cleaning system, Air Compressor of required capacity along with required air pipe line etc. shall be supplied.

Further, each of the TTP shall be equipped with Auto samplers at the inlet and treated (outlet) point. Each of the online real time multi parameter continuous monitoring system shall be integrated with the Auto sampler. The online real time multi parameter continuous monitoring system is required to communicate with the auto sampler for exceedance sample so that it can store sample in Auto sampler for Lab analysis. This is to ensure that the sample taken by the auto sampler and the multi parametric analyzer are of the same time period. Contractor shall not the importance of this requirement and include the same in datasheet submission for both auto sampler and real time monitoring equipment.

All required calibration standard chemicals & reagents, are required to be provided for a complete duration of the operation and maintenance period for all mentioned parameters.

The online real time multi parameter continuous monitoring system shall accept the input signal from existing outlet Flow meter at the Tertiary treatment plant for display as well as Data transmission. Required cabling, any other hardware to achieve the same shall be under the contractor scope of work under this contract.

The online real time multi parameter continuous monitoring system shall be equipped with USB port for download of stored measurement data along with diagnostic files for easy troubleshooting. The minimum data storage for all the parameters shall be three months in the non-volatile memory of the equipment.

The online real time multi parameter continuous monitoring system shall be equipped with suitable communication ports for integration/ provide data to sewage treatment control system (PLC based SCADA system).

The online real time multi parameter continuous monitoring system shall have multiplexing facility to add minimum five sample streams to allow connection of additional sample stream for future requirements.

The contractor shall provide mandatory spares along with the online real time multi parameter continuous monitoring system for the entire contract which shall include:

1) 1 No of Electronic circuit Boards,
2) 1 No of Display Board,
3) Tubing's,
4) 1 No of Cleaning Pump,
5) 1 No of Spectroscopic Modules & all other required spares.

Technical requirements:

A) COD (Chemical Oxygen Demand)

Measuring Principle	UV-VIS Spectroscopy with entire spectrum scanning between 180 nm to 800 nm.
Measuring Range	0 –1000 mg/l(Min)
Accuracy	± 2% on standard solution
Repeatability	± 1 mg/l
Response Time	< 5 min.
Cleaning	Automatic cleaning

B) BOD (Biological Oxygen Demand)

Measuring Principle	UV-VIS Spectroscopy with entire spectrum scanning between 180 nm to 800 nm.
Measuring Range	0 – 1000 mg/l(Min)
Accuracy	± 2% on standard solution
Repeatability	± 1 mg/l
Response Time	< 5 min.
Cleaning	Automatic cleaning

C) Ammonical Nitrogen (NH4-N)

Measuring Principle	UV Absorption after gas stripping. Measurement should be in gas phase for completely interference free measurement.
Measuring Range	0 – 100 mg/l (Min)

Accuracy	± 5% on standard solution
Repeatability	± 0.2 mg/l
Response Time	< 5 min.
Cleaning	Automatic cleaning

D) Total Nitrogen

Measuring Principle	UV-VIS Spectroscopy with entire spectrum scanning between 180 nm to 800 nm.
Measuring Range	0 – 100 mg/l
Accuracy	± 2% on standard solution
Repeatability	± 0.1 mg/l
Response Time	< 5 min.
Cleaning	Automatic cleaning

E) Total Suspended Solids (TSS)

Measuring Principle	UV-VIS Spectroscopy with entire spectrum scanning between 180 nm to 800 nm.
Measuring Range	0 – 2000 mg/l
Accuracy	± 2% on standard solution
Repeatability	± 2 mg/l
Response Time	< 5 min.
Cleaning	Automatic cleaning

F) pH

Measuring Principle	Electrochemical Method
Measuring Range	0 – 14 pH
Accuracy	± 2% on standard solution
Repeatability	± 0.01 pH
Response Time	< 1 min.

G) Dissolved Oxygen

Measuring Principle	Optical Method
Measuring Range	0 – 20 mg/l
Accuracy	< 1 % of full scale
Resolution	< 0.01 mg/L
Precision	< 0.02 mg/L
Response time	< 1 min
Cleaning	Automatic cleaning

H) Temperature

Measuring Range	0 – 80”C
Accuracy	< 0.1 C
Resolution	< 0.1 C
Precision	< 0.1 C
Response time	< 1 min
Cleaning	Automatic cleaning

I) Online Real Time Multi Parameters Continuous Monitoring System for Influent (1No.) and Treated water (Outle-1no.) Parameters system

Operating Pressure	Contractor to specify
Operating Temperature	Sample temperature: 0 ºC to 80 ºC
Operating Flow	Contractor to specify
Enclosure protection	IP65 minimum
Communication	RS232 or RS485 output - USB port required for USB/ pen drive connection.
Memory	As specified in the technical requirements in this document
Display	Color LCD, with LED backlight Resistive touch screen display.
Measuring time/ Response time	1 Min Programmable
Measuring Cycle	Continuous.
Power supply	90- 264 VAC 50/60 Hz
Cleaning method	Equipment should have facility to start cleaning cycle automatically as per user defined time interval.
Calibration requirement	Required. Shall have auto zero calibration facility. Equipment shall have facility to start auto zero calibration as per user defined time interval. Span Calibration: Shall perform as per laboratory measurement data.
UV Light Source	Xenon Flash Lamp
Expandability of measurement	Equipment shall have facility to expand measurement to meet future compliance requirements (if any). Equipment shall have capability to add parameters like NO3 & Conductivity, turbidity at no extra cost. Equipment shall have capability to add other parameters as mention below & should be facilitate to upgrade with Minimal cost using same enclosure. Oil in Water: Measurement Technique by UV Fluorescence Chromium, Phosphate. Measurement Technique by Colorimetric TDS/Conductivity: Measurement Technique by Electrochemical.
Additional Features	Should have Automatic Zero calibration facility which can be programmable as per user defined interval.

	UV source should be Xenon flash lamp with life more than 10 years.
	Equipment should be cabinet type (IP 65) for easy operation, maintenance & troubleshooting. If not the complete instrument shall be provided with IP-68 enclosure
	USB port for downloading stored measurement data.
	Should have robust flow cell which allows very high level of suspended solid without clogging and also suitable for highly corrosive water Sample.
	Should have automatic turbidity compensation facility by a dual wavelength
	USB port is required for recorded measurement download, screen copy function (easy troubleshooting) & software update

13.27 Particular Control & Automation Requirements

A. General

This part covers the Particular requirements for the design, supply, installation, Inspection and testing of Programmable Logic Controllers (PLC) and Supervisory Control and Data Acquisition (SCADA) and associated plant and materials.

13.28 Design, Supply and Construction Requirements

TTP PLC shall be provided as a Hot-Standby configuration to perform combinational and sequential logic functions, status monitoring and reporting functions with counter and timer facilities.

In particular, the following configuration shall be applicable across the TTP.

a) TTP Main Plant PLC: Hot standby PLC

Main PLC system shall comprise of necessary hot standby PLC processors, Simplex input/output (I/O) modules(duplex I/O modules shall be provided for only critical inputs/outputs, the same shall be decided during detail design engineering), redundant communication interface modules, redundant power supply modules and Human-Machine Interface (HMI) required performing the desired functions.

PLC shall have the following attributes as a Hot Stand-by Controller.

- carry out sequential logic implementation for operations of plant;
- carry out computation and interfacing for data acquisition, data storage and retrieval;
- it shall accept downloaded program from a programmer;
- it shall have different functional modules to perform the desired functions;
- it shall scan the inputs in time cycles and update the status of its outputs.

The PLC system shall be expandable, OPC Compatible and shall be modular in construction, so as to be capable of future expansion without hardware modifications. PLC s shall be microprocessor based. PLC s shall use standard known protocols and structures for communication outside the system.

In case of system failure or power supply failure the outputs shall attain a predetermined fail safe condition (this shall normally be 'off').The PLC used shall have a proven record in the type of application concerned and in the prevailing environmental conditions.

All PLC based Systems should be housed in air conditioned environment. The contractor shall submit the sizing calculations for the air conditioning system for review and approval.

The contractor shall refer the approved vendor list for the PLC system and hardware, elsewhere in this document.

b) Remote input/output modules (RIO)/Panels

The PLC system shall consist of field remote input/output modules (RIO) and panels. Each RIO panel shall consist of redundant communication modules, power supply modules, minimum 16" color panel mounted HMI with touch screen functionality. It shall be possible to view and acknowledge the alarms and view set points for the particular process from the HMI etc.

c) I/O Modules:

Standard rack mounted plug in I/O modules shall be provided. I/O Modules should be of the same series as the PLC CPU. Refer the approved vendor list for the PLC system and hardware, elsewhere in this document.

Field wiring shall be terminated in screwed terminal blocks and interconnected to the processor I/O system with prefabricated cables and plug in card type connectors. I/O Modules should be hot swappable.30% extra modules of installed capacity for each type of module shall be provided as spare. In addition to the above, provision shall be made for future expansion of additional 30% extra I/O modules of the installed capacity in the panel. The panel drawings shall reflect the same.

I/O modules shall be as follows:

a) inputs shall be opto isolated.;
b) filters shall be provided for noise rejection;
c) output status shall be indicated by an LED;
d) all outputs shall be fuse protected and have fuse failure indication the fuses may be mounted externally from the output module;
e) all the modules shall be of addressable type.
f) Ethernet I/O modules shall be connected to the PLC by on board Ethernet 10/100 Base T connection port. Ethernet I/O modules shall support multiple communications including TCP/IP and Modbus ASCII and RTU allowing connection to any device supporting these protocols over standard Ethernet backplane.

Each PLC shall have memory protected built in historical archiving/data logging of system alarms & events and process variables. Data logger shall be able to log data based on time or an event. PLC shall have enough memory allocated to allow 200,000 time and data stamped discrete and /or analog values to be archived. The historical archive shall allow the oldest data to roll off the system as memory is used keeping the 200,000 most current data points available. Process point time stamping frequency shall be selectable within the configuration software. It shall be possible for the archived data to be exported in CSV format allowing use with standard spreadsheet and data software applications

The PLC system shall be expandable, OPC Compatible (OPC should be a built in feature of the software and hardware. No external software patch or hardware module is allowed) and shall be modular in construction, so as to be capable of future expansion without hardware modifications.

d) Dual Redundant Processors (CPU)

The master station shall be provided with two identical central processors configured such that they operate in Hot-Standby mode.

Redundant system with hot back up redundancy feature should be built in the CPU. Software engineered hot backup systems are not acceptable. CPU should have the memory expansion capability up to 7 MB.

SCADA connectivity with the CPU will be on dual Ethernet network (10/100 Mbps with open Modbus TCP/IP protocol). On the event of hardware failure in primary system the standby system will provide dual connectivity with the SCADA.

Redundancy of switch for SCADA (industrial grade managed switch) connectivity is to be provided. PLC CPU and I/O modules shall be of the same logic family.

The system shall be designed and implemented such that when the Main processor fails, the Standby one shall automatically take over. The changeover shall be seamless, smooth and without any time delay and shall not cause any disruption to the overall distributed control system and to the ongoing processes.

The PLC system shall be expandable (OPC Compatible) and shall be modular in construction, so as to capable of future expansion without hardware modifications.

The system hardware, application software and database shall be sized to accommodate a total of 50% increase in signal capacity and up to 100% increase in an individual zone.

PLC s shall be microprocessor based. PLC s shall use standard known protocols and structures for communication outside the system. In case of system failure or power supply failure the outputs shall attain a predetermined fail safe condition (this shall normally be 'off').The PLC used shall have a proven record in the type of application concerned and in the prevailing environmental conditions.

Application logic programs shall be fully compliant with all five logic development methods detailed in IEC 61131-3. The PLC shall be powered by two independent sources provided by the UPS system and all internal operating supplies shall be derived from the UPS.

The power supplies, I/O modules, CPU and communication modules shall be monitored by the PLC and shall be available by report. The same shall be monitored on the SCADA screen.

During the times of the battery discharge, the PLC shall initiate an orderly self-shutdown and automatically restart on the main power restoration without the need for reloading or initiation of any kind. The PLC shall comply with the specification specified elsewhere in this specification.

e) Central Processing Units

The central processing units (CPU) shall be a high performance processor with modular configuration suitable for real time process applications. The following additional features shall be provided:

Redundant system with hot back up redundancy feature should be built in the CPU. Software engineered hot backup system will not be not acceptable. CPU should have the memory expansion capability of minimum 7 MB.

SCADA connectivity with the CPU will be on dual Ethernet network (10/100 Mbps with open Modbus TCP/IP protocol). On the event of hardware failure in primary system the standby system will provide dual connectivity with the SCADA.

Redundancy of switch for SCADA (industrial grade managed switch) connectivity should be provided. Communication between CPU and peripherals shall be by an I/O bus. The individual device, interfaces shall be capable of being plugged into the I/O bus. On resumption of power following a power failure the PLC shall automatically restart its controlling function.

CPU shall have a real time clock capability to accept a time synchronization pulse and adjust its internal clock with the pulse. CPU shall have extensive self-diagnostic facilities and watch dog timers to identify faults at card levels

f) Memory Unit

Memory unit shall comprise of highly reliable memory chips which are industry standard, proven design with fast random access and suitable for operation in process environments. Main memory shall be modular and facility shall be provided for the upgrading and expansion of memory to meet future demands.

Not less than 50 % spare program memory and data memory space shall be provided. System initialization and application software shall be stored in EEPROM or EPROM. Operating data shall be stored in a RAM fitted with an internal battery backup.

g) I/O Modules

Standard rack mounted plug in I/O modules shall be provided. I/O Modules should be of the same series as the PLC CPU. Field wiring shall be terminated in screwed terminal blocks and interconnected to the processor I/O system with prefabricated cables and plug in card type connectors. I/O Modules should be hot swappable.

30% extra modules of installed capacity for each type of module shall be provided as spare.

I/O modules shall be as follows:

- inputs shall be opto isolated.;
- filters shall be provided for noise rejection;
- output status shall be indicated by an LED;
- all outputs shall be fuse protected and have fuse failure indication the fuses may be mounted externally from the output module;
- all the modules shall be of addressable type.
- Ethernet I/O modules shall be connected to the PLC by on board Ethernet 10/100 BaseT connection port. Ethernet I/O modules shall support multiple communications including TCP/IP and Modbus ASCII and RTU allowing connection to any device supporting these protocols over standard Ethernet backplane.

h) Analogue Input Modules

They shall consist of an input isolation unit, signal conditioning unit and an analogue to digital converter (ADC). In addition, the following features shall be provided.

- cross talk attenuation
- provision for monitoring of the ADC for overflow detection
- gain amplifier with high common mode rejection ratio
- accuracy for analogue signals shall be 0.5%

i) Digital Input Modules

The following design features shall be provided.

- contact bounce protection;
- choice of type of contacts.

j) Digital Output Modules

The digital output module shall provide contact closure output by driving relays. The features to be provided are as follows:

- contact bounce protection shall be provided
- relay output shall be provided to operate pump motors and motorised valve actuators
- fail safe position in case of output module failure and fault indication

PLC's provided under this specification shall be capable of performing the necessary logic to control the system as previously defined. These capabilities shall include, but not be limited to the following:

1) Discrete input/output	10) Latch/unlatch relays

2) Analog input	11) Counters
3) Analog output	12) Comparators
4) Timers	13) Ladder logic
5) Pump Controller	14) Flow Totalization/ Integration
6) Pump Alternation	15) Intrusion Detection
7) Mathematical Function Blocks	16) Time of Day Control w/Lockout
8) Stage Blocks	17) Ramp Blocks
9) Trending	18) Data Logging

A. PLC Programming

PLC programming shall be carried using functional block diagrams (FBD). The logic shall be prepared using proprietary programming software and shall be comprehensively annotated with subroutine and rung comments to assist further development and maintenance.

The system shall support a simple programming of the application software comply with IEC 61131-3.

The system shall support a structured, modular programming. At least the following standard operations shall be applicable:

1) Logic functions (such as AND/OR/AND NOT etc.);
2) Timer functions (externally adjustable);
3) Counter functions;
4) Skip functions;
5) Comparison functions;
6) Limit value functions;
7) Arithmetic functions;
8) Physical unit functions;
9) Closed-loop functions such as P/PI/PID/etc.

The Contractor shall submit the logic diagrams for review. The Contractor shall include the as-built logic in the final submission.

B. Programming Unit

The programming unit –Industrial grade laptop (16" screen) shall be of the portable type, designed to be used during commissioning on site. A functional keyboard which supports different type of programming methods shall be included, as well as a LCD display.

On a minimum, the following functions shall be included:

i) On-line programming
ii) Off-line programming
iii) Flexible corrections during input
iv) Full screen editing functions
v) Absolute and symbolic programming
vi) Input of comments and title blocks for complete documentation
vii) Complete application software documentation functions. Printouts of application
viii) Software logic functions shall preferably be in Ladder logic diagrams.
ix) Load and transfer functions

The portable programming unit with minimum 16" screen shall be provided complete with proprietary PLC programming and SCADA software complete with plant mimics and documentation software. Communications cables required to interact with the PLC, (E.g.: Modbus Cable) would be supplied by the contractor.

The software shall provide facilities for:

- carrying out program revision management;
- insertion of comprehensive program subroutine and rung comments;
- search and find and search and replace 'contacts' and 'coils';
- simulation functions and testing of the program by changing the status of contacts and monitoring the outputs;
- preparation of coil and contact list and their locations and memory maps;
- make system backup copies while the system is online;
- upload and down load programs to the PLC on line;
- Carry out on line maintenance and fault finding on the PLC.

C. HMI

The HMI shall be with 16" color screen and with touch screen capabilities with IP-65 rating.

All Remote I/O panels which are connected to the main plant PLC based SCADA system shall be equipped with a 16"minimum, panel HMI .The HMI graphic shall be suitable for day to day operation by non-computer literate personnel in the monitoring and operation of the treatment works.

The HMI shall provide efficient and safe operation of the process plant by detecting alarm and error conditions, alerting the operator to these conditions both visually and audibly, monitoring all important system parameters and providing facilities for plant optimization. The system will allow operators, technicians and Employer Representatives to issue commands to change system parameters, start and stop equipment, provide configuration tools and operate diagnostic facilities.

The System shall perform all the necessary functions for the optimum monitoring, control and operation of the particular system. HMI unit along with software packages shall be considered, and also those software packages and Hardware shall be compatible with TCP / IP protocols as well as OPC communication (Open Standard Communication).

The Human Machine Interface (HMI) shall offer a high resolution and high brightness touch screen and include support for processors for up to 1GHz pulse wave,. The HMI shall be rugged and CE-certified and shall offer protection from vibration and changing ambient temperatures, shall include Built-in stereo speakers to increase utility and provide operational flexibility to the plant operators.

D. Ethernet Switches

The contractor shall only provide managed industrial grade managed Ethernet switches under this contract. All switches shall be in redundant configuration.

13.29 Minimum I/O Requirements for Auto mode Control operation of the Plant:

On a minimum, the control design shall incorporate the I/O requirements which are indicated in the table. All process & Instrumentation Diagrams (P&ID) shall incorporate & depict the minimum I/O requirements as indicated in the table below.

Design shall include complete auto mode of operation of the entire TTP and associated plants/stations with all necessary interlocks and safety mechanisms.

Minimum I/O to be provided under this contract for the Control system and to be included in the system design is as under:

Sl No	TYPE	MINIMUM I/O'S TO BE CONSIDERED AND INCLUDED
1.	Pump, Motor	Start, Stop, Available, Auto, Off, Manual, Run, Emergency Stop, Fault, Speed ref, Motorized valve status on inlet and outlet,
2.	Valve	Available, ,Auto, Off, Manual, Open, Close, Travelling Indication, Fault ,Motorized valve status on inlet and outlet of pumps ,blowers,etc,
3.	Drives	Available, ,Start, Stop, Auto, Off, Manual, Run, Emergency Stop, Fault
4.	Blower	Available, , Start, Stop, Auto, Off, Manual, Run, Emergency Stop, Fault
5.	Level Indicator	HH, H, L, LL, Analog value,
6.	Level Switch	HH, H, L, LL,
7.	Analytical Instruments	Analog Value,
8.	Pressure Indicator/transmitters	Shall be provided at **(**in addition to individual pumps, blowers**,** at common discharge end of pumps, blowers, dosing pumps etc...): Analog Value,
9.	Flow Indicator/Transmitters	Shall be provided at **(**in addition to other plant flows**,** at common discharge end of pumps, blowers, dosing pumps etc...): Analog value, totalizer,

13.30 Typical Drive Control Philosophy to be provided on a minimum shall be as follows:

SL. NO.	DESCRIPTION	Type of I/O	No of I/O
1.	**PLC INTERFACE FOR UNIDIRECTIONAL HT DRIVE / LT BREAKER CONTROL DRIVE (Signal Exchange has been envisaged between PLC and switchgear)**		
a.	Start Command	DO	1
b.	Stop Command	DO	1
c.	ON Feedback	DI	1
d.	OFF Feedback	DI	1
	Auto, Off, Manual	DI	3
e.	Swgr. Disturbance (Overload relay operated/ control supply fail/	DI	1
	Emergency LPBS stop)	DI	1
	Available	DI	1
f.	Electrical Trip (Motor Protection Relay)	DI	1
g.	Switchgear Available (breaker in service position, switchgear in remote & breaker spring charged)	DI	1
h.	Pump bearing temperature measurement	AI	2
i.	Motor Bearing temperature measurement	AI	2
j.	Motor Winding temperature measurement	AI	6
k.	Current Transducer input	AI	1
2.	**PLC INTERFACE FOR UNIDIRECTIONAL LT DRIVE (Signal Exchange has been envisaged between PLC and PCC/MCC)**		
a.	Start Command	DO	1

SL. NO.	DESCRIPTION	Type of I/O	No of I/O
b.	Stop Command	DO	1
c.	ON Feedback	DI	1
d.	OFF Feedback	DI	1
	Auto, Off, Manual	DI	3
	Available	DI	1
e.	Swgr/MCC Disturbance (Overload relay operated/ control supply fail/	DI	1
	Emergency LPBS stop)	DI	1
f.	Switchgear/MCC Available (switchgear/MCC in remote)	DI	1
3.	**PLC INTERFACE FOR BIDIRECTIONAL LT DRIVE- For Integral starters (Signal Exchange has been envisaged between Actuator and PLC.)**		
a.	Open Command	DO	1
b.	Close Command	DO	1
c.	Integral starters Fault	DI	1
d.	Open limit switch feedback	DI	1
e.	Close limit switch feedback	DI	1
	Auto, Off, Manual	DI	3
	Available	DI	1
f.	Position Transmitter (For inching type Drive)	AI	1
g.	Command	AO	1
4.	**PLC INTERFACE FOR BIDIRECTIONAL LT DRIVE-For Non-Integral starters (Signal Exchange has been envisaged between Actuator and PLC.)**		
a.	Open Command	DO	1
b.	Close Command	DO	1
	Auto, Off, Manual	DI	3
c.	Swgr/MCC Disturbance (Overload relay operated/ control supply fail/	DI	1
	Emergency LPBS stop)	DI	1
	Available	DI	1
d.	Switchgear/MCC Available (switchgear/MCC in remote)	DI	1
e.	Open limit switch feedback	DI	1
f.	Close limit switch feedback	DI	1
g.	Position Transmitter (For inching type Drive)	AI	1
5.	**PLC INTERFACE FOR SOLENOID DRIVE (Single coil)**		
a.	Energise or Deenergise	DO	1
b.	Open limit switch feedback	DI	1
c.	Close limit switch feedback	DI	1
6.	**PLC INTERFACE FOR SOLENOID DRIVE (Double coil)**		
a.	Energise	DO	1
b.	Deenergise	DO	1
c.	Open limit switch feedback	DI	1
d.	Close limit switch feedback	DI	1
7.	**PLC INTERFACE FOR PNEUMATIC DRIVE**		
a.	Command to I/P converter	AO	1
b.	Position Transmitter	AI	1

SL. NO.	DESCRIPTION	Type of I/O	No of I/O
c.	Open limit switch feedback	DI	1
d.	Close limit switch feedback	DI	1
e.	Command to Solenoid valve (Wherever applicable)	DO	1

13.31 Approved Vendor/Manufacturer/Make List-Instrumentation

The naming of a manufacturer in this specification is not intended to eliminate competition or prohibit qualified manufacturers from offering equipment. Rather, the intent is to establish a standard of excellence for the material used, and to indicate a principle of operation desired.

i) List of Makes for Instruments:

Sr. No.	Description	Vendor/Manufacturer/Make
1	LEVEL INDICATOR TRANSMITTER	M/S ABB-GERMANY M/S ENDRESS+HAUSER M/S YOKOGAWA M/S SIEMENS M/S EMERSON M/S ROYCE INSTRUMENTS M/S HITACHI HIGH-TECH
2	FLOW METERS/FLOW INDICATOR/ TRANSMITTER (ELECTROMAGNETIC, THERMAL, ULTRASONIC)	M/S EMERSON-USA M/S ENDRESS+HAUSER M/S SEIMENS M/S ABB-GERMANY M/S FORBES MARSHALL M/S HITACHI HIGH-TECH M/S KELVIN INSTRUMENTS PVT LTD M/S AICHI TOKEI DENKI CO LTD
3	LEVEL/FLOAT SWITCHES	M/S ABB-GERMANY M/S ENDRESS+HAUSER, M/S KROHNE GMBH GERMANY M/S P&F GERMANY M/S LEVCON, M/S. PUNE TECHTROL M/S HITACHI HIGH-TECH
4	PRESSURE GAUGES	M/S GENERAL INSTRUMENTS M/S. BAUMER M/S ASAHI M/S WIKA M/S MIGISHITA (JAPAN) M/S NAGANO KEIKI
5	PRESSURE INDICATOR TRANSMITTER & SWITCHES	M/S EMERSON-USA M/S ENDRESS+HAUSER M/S SIEMENS M/S ABB-GERMANY

Sr. No.	Description	Vendor/Manufacturer/Make
		M/S. BAUMER M/S HITACHI HIGH-TECH M/S FUJI ELECTRIC
6	ONLINE RESIDUAL CHLORINE ANALYZER	M/S ENDRESS+HAUSER M/S DKK -JAPAN M/S PROCESS INSTRUMENTS –UK M/S TETHYS INSTRUMENTS-FRANCE, M/S YOKOGAWA (JAPAN)
7	TEMPERATURE INDICATOR TRANSMITTERS	M/S ENDRESS+HAUSER M/S YOKOGAWA (JAPAN) M/S ABB-GERMANY M/S SIEMENS M/S FUJI ELECTRIC M/S HAYASHI DENKO (JAPAN)
8	ANALYTICAL ONLINE INSTRUMENTS (DO, ORP, pH, TURBIDITY,SLUDGE BLANKET MONITOR)	M/S IN SITU(USA), HACH USA M/S ENDRESS+HAUSER M/S PROCESS INSTRUMENTS- U.K M/S DKK (JAPAN) M/S AXIS SOLUTIONS PVT LTD M/S KELVIN INSTRUMENTS PVT LTD
9	ONLINE REAL TIME INFLUENT & EFFLUENT MONITORING SYSTEM	M/S TETHYS INSTRUMENTS-(FRANCE) M/S DKK (JAPAN) M/S IN SITU-(USA) M/S AQUALABO-FRANCE M/S AXIS SOLUTIONS PVT LTD M/S SCAN M/S KELVIN INSTRUMENTS PVT LTD
10	AUTO SAMPLERS	M/S TELEDYNE ISCO -USA M/S CAMPBELL SCIENTIFIC –USA M/S WATERSAM-GERMANY M/S QCEC M/S KELVIN INSTRUMENTS PVT LTD
11	LABORATORY EQUIPMENT	M/S MACHERY –NAGEL M/S DKK (JAPAN) M/S YAMOTO SCIENTIFIC CO.LTD (JAPAN) M/S IDEXX M/S IN-SITU M/S SHIMADZU (JAPAN) M/S SAVANT M/S KELVIN INSTRUMENTS PVT LTD M/S PROMIVAC M/S LABCARE M/S HIMEDIA M/S ACZER
12	UN-INTERRUPTIBLE POWER SUPPLY SYSTEMS	M/S FUJI ELECTRIC M/S HITACHI

Sr. No.	Description	Vendor/Manufacturer/Make
		M/S APC M/s DELTA M/S NIPPON KEIDENKI WORKS M/S MEIDENSHA CORPORATION M/S FURUKAWA BATTERY
13	BATTERIES	M/S AMCO M/S EXIDE M/S SEC M/S AMAR RAJA M/S SANKEN ELECTRIC M/S FURUKAWA BATTERY
14	PANELS	M/S RITTAL M/S ELDON M/S CEPL M/S HOFFMAN M/S UDIT ENGINEERS M/S SUNSHINE
15	CABLES	M/S UNIVERSAL CABLES M/S HAVELL'S M/S CCI M/S FINOLEX M/S NICCO M/S TCL CABLES M/S DELTON CABLES LIMITED

Note-1: In order to achieve standardization for appearance, operation, maintenance, spare parts and manufacturer's service, like items of equipment provided hereunder shall be the end products of one (1) manufacturer.

Note-2: All products shall be completely manufactured in the country of Origin as indicated. Assembled products shall not be accepted.

Note-3: In the event that the contractor wishes to propose alternate makes for the equipment mentioned above, he shall submit the following during detailed engineering:

1) Demonstrate that the proposed makes are "equivalent " to the approved makes. The contractor shall ensure that alternate makes proposed, shall comply completely to the tender specifications, before the same is submitted for approval.
2) Submit ISO certificates for the OEM.
3) Submit quality certificates that the equipment adheres to, as required under this contract.
4) Submit product brochures for the proposed equipment.
5) Manufacturer involved in manufacture of specified equipment for at least 10 years before bid date
6) End user performance certificates for minimum 10 successful individual installations of similar size and application as per this contract with the proposed equipment and model no, commissioned in last 5 years before bid date and satisfactorily operating for at least five years before bid date. Contractor to submit end user reference certificates for each of the installations referenced.
7) Manufacturer to provide full contact information for each reference as part of technical bid.

13.32 Approved Vendor/Manufacturer/Make List-Automation

The naming of a manufacturer in this specification is not intended to eliminate competition or prohibit qualified manufacturers from offering equipment. Rather, the intent is to establish a standard of excellence for the material used, and to indicate a principle of operation desired.

Sr.	Description	Manufactures/Makes

No.				
1	WORKSTATIONS, SERVERS, LAPTOP NOTEBOOK	M/S-DELL M/S-HP M/S-FUJITSU M/S-TOSHIBA		
2	PROGRAMMABLE LOGIC CONTROLLERS & IO MODULES	**Make**	**CPU Series**	**IO Series**
		SCHNEIDER ELECTRIC	QUANTUM SERIES	QUANTUM 140 SERIES
		SIEMENS	S7-400H	ET-200M SERIES
		ALLEN BRADLEY	CONTROL LOGIX 1756 SERIES	CONTROL LOGIX 1756 SERIES
		MITSUBISHI ELECTRIC	R16P	RSERIES
		OMRON	CS1D	CS1D
3	SCADA PROGRAMMING SOFTWARE	WIN CC, RS VIEW, WONDERWARE SCADA, MC WORKS, CX-SUPERVISOR Note: All software's shall be of the latest series version and shall include both runtime and developer versions.		
4	HISTORIAN SOFTWARE	WONDERWARE HISTORIAN MC HISTORIAN SIMATIC PROCESS HISTORIAN FACTORY TALK HISTORIAN SE PROGEA- MOVICON		
5	SCADA supply and Integrator	M/s SCHNEIDER ELECTRIC M/s MITSUBISHI ELECTRIC M/s ABB M/s SIEMENS		
6	REMOTE TERMINAL UNIT	M/S-SIEMENS, M/S-ABB, M/S MITSUBISHI, M/S-OMRON, M/S SCHNEIDER ELECTRIC, M/S TOSHIBA		
7	DC POWER SUPPLY	M/S-APLAB, M/S-WAGO, M/S-PHOENIX CONTACT, M/S-MEAN WELL, M/S-WEIDMULLER, M/S-OMRON. M/S-SHAVISION		
8	PANEL HMI	M/S-ADVANTECH, M/S-MITSUBISHI, M/S-PANASONIC, M/S-SIEMENS, M/S- ABB, M/S-OMRON M/S-TOSHIBA		
9	LED MONITORS/DISPLAYS/VDU	M/S-SAMSUNG, M/S-LG,		

		M/S- SONY, M/S-DELL, M/S-HP
10	PRINTERS	M/S- CANON, M/S- XEROX, M/S-EPSON, M/S-RICOH
11	CONTROL ROOM CONSOLES & FURNITURE	M/S PYROTECH WORKSPACE, M/S EVANS, M/S QUEST, M/S WINSTED

Note-1: In order to achieve standardization for appearance, operation, maintenance, spare parts and manufacturer's service, like items of equipment provided hereunder shall be the end products of one (1) manufacturer.
Note-2: All products shall be completely manufactured in the country of Origin as indicated. Assembled products shall not be accepted.
Note-3: In the event that the contractor wishes to propose alternate makes for the equipment mentioned above, he shall submit the following during detailed engineering:
Note-4: For all systems, contractor shall ensure compliance to Qualification criteria for agency/system integrator to supply, execute and commission the system as detailed in General requirements.

1) Demonstrate that the proposed makes are “equivalent ” to the approved makes or superior. The contractor shall ensure that alternate makes proposed, shall comply completely to the tender specifications, before the same is submitted for approval.
2) Submit ISO certificates for the OEM.
3) Submit quality certificates that the equipment adheres to, as required under this contract.
4) Submit product brochures for the proposed equipment.
5) Manufacturer involved in manufacture of specified equipment for at least 10 years before bid date
6) End user performance certificates for minimum 10 successful individual installations of similar size and similar application as per this contract with the proposed equipment and model no, commissioned in last 5 years before bid date and satisfactorily operating for at least five years before bid date.
7) Manufacturer to provide full contact information for each reference as part of technical bid.

13.33 Supervisory Control and Data Acquisition System (SCADA)

The SCADA shall be a fully integrated microprocessor based control and data acquisition system which will monitor, control, display, record, archive plant and historical data and trend all assigned plant inputs and outputs. The SCADA shall be a fully dual redundant microprocessor based computer system such that reliable and fully automatic plant control can be achieved.

The main process monitoring and control shall be by means of VDU based process operator workstations that shall be located in the central control room.

SCADA system would be dual redundant server system. The system shall be designed and implemented such that the failure of a central processor or HMI console does not inhibit continuous automatic control of the plant.

Failure of a single outstation or communications to that outstation shall not effect control or operation of any other outstation, unless the failed outstation provides essential data to another outstation, in which case the non-failed outstations shall revert to a fail-safe mode.

An alarm shall be generated whenever a communications system failure occurs.

The SCADA system shall provide a complete monitoring & control of the entire TTP via the redundant PLC based control system and RIO system.

TTP SCADA system shall comprise the following on a minimum:

a) Dual redundant SCADA servers with SCADA server software with minimum twenty five thousand tags license and web servers:
b) Historian server system inclusive of the historian software to match the tag database of the SCADA software, i.e. Twenty five thousand tags.
c) Engineering & Operator work stations loaded with SCADA software and with latest Windows Operating system, minimum 1TB storage, latest processor, etc.
d) LED SCREENS, 65" (networked with SCADA servers to display the process screens, alarms & reports, with all required hardware & software accessories)
e) Redundant industrial managed Ethernet switches
f) Licensed MS Office & Antivirus software to be loaded on each system
g) Industrial grade control system console to house the entire PLC based SCADA system and other equipment as indicated in the system configuration diagram.
h) All required software and hardware to implement the system as indicated in the specifications and system configuration drawings.
i) Each TTP Bulk transfer of data (complete plant operational data inclusive of lab data and TTP Data) to be transmitted to CP-24 Centralized SCADA center and MIS-2 center at Shimsha Bhavan, tthrough redundant GPRS communication system.
j) Monitoring of TTP in real time and receiving of TTP data from the each TTP control system and displaying the TTP complete plant mimics on the TTP SCADA screen.
k) Control of TTP control system from the TTP control system as and when required. The feature shall be demonstrated during control system FAT.

The SCADA system shall follow the International Standards Organization (ISO), Open Systems Interconnect (OSI), reference model guidelines. All central system hardware and software devices shall be interconnected using a bus topology data highway. The communications protocol used shall generally meet the requirements of the ISO.
The system shall provide efficient and safe operation of the complete plant by detecting alarm and error conditions, alerting the operator to these conditions both visually and audibly, monitoring all system parameters and providing complete facilities for plant operation and optimization.

The System shall perform all the necessary functions for the optimum monitoring, control and operation of the entire system. For each abnormal condition, Plant failure, Plant unavailable or failure to respond to a command within a given period, the system shall provide the appropriate alarm.

Printed and archived alarms shall be time and date stamped for occurrence and acceptance. Alarms, logs and reports shall be output to separate printers. Alarms shall be in red. The ability to generate alarms within the system software based upon digital and / or analogue events and set points shall be provided.

An alarm horn with silence button shall be provided to alert the operator of an alarm condition. Specific alarm, monitoring and control input / output requirements shall be determined from the particular control specifications and the Project Drawings.

13.34 SCADA Software Functions

General:

1) The Contractor shall be responsible for supplying complete software packages to enable the equipment to operate as stated in this specification. Provision must be made for the adding of further software tasks as and when required. All software functions shall be user friendly, with instruction and messages to aid the operator. The Contractor shall make available all standard software functions, even if not specifically detailed in the specification.
2) The computers shall utilize a real time multi-tasking and networked operating system with a proven track record in real time control applications.
3) The Operating System shall be latest Windows operating system, loaded with MS-Office latest licensed version suitable for interconnection with external networks in a Wide Area Network (WAN) configuration, where specified.

4) The Application Software shall provide communication with other industrial standard open networks. The Software shall support Object Linked Embedding for Process Control (OPC).OPC should be a in-built feature of the software.
5) The System shall support a fully distributed 64 bit Client/Server architecture. The System shall include Visual Basic for Applications (VBA) as a built-in programming language. Facility shall be available for building custom objects using VBA. Object oriented graphics and tools to easily build reusable control strategies. ODBC Application Program Interface (API) capable of collecting and writing secure real-time electronic records to one or more relational database.
6) The software shall support OPC standards as both a client and a server for fast and reliable communications with a wide variety of hardware devices. Provide Active-X controls with selection of third-party Active-X controls for ready-made solutions without VBA programming. The SCADA software shall use SQL server as the integral database.
7) A standard software package, such as Crystal Report shall be provided to facilitate generation of free format, intuitive and presentation quality reports.
8) The engineering Workstation shall be provided with simulation tools to support off-line testing of the control logics.
9) The Server shall provide the master clock for the SCADA time synchronization.
10) SCADA software design shall include de-activation of CTRL+ALT_DEL windows feature.
11) The system software shall be from the SCADA manufacturer as indicated in the approved vendor list elsewhere in this specification.. Third party software is not acceptable. It is a requirement that the system be supported by on line configuration and editing of all VDU mimic displays and database and to create new displays and additional database.
12) Operational mimics and other graphics shall be presented in an industry standard graphical user interface (GUI) format. A minimum of two active windows shall be displayable concurrently and not more than three windows. Both text and graphics shall resize automatically to accommodate changes made to the size of a window. The system shall be designed to minimize the operator's use of the keyboard. All major functions shall be accessible on-screen through use of the mouse or track ball.
13) Operator system entry, for each area will be password coded with different levels of entry depending on the level of authority of the operator. Development and systems level entry passwords will be provided for engineering workstations. Each action taken by any operator at any level of entry, or at any operator terminal, shall be log file recorded and time and date stamped. Log in and out time and dates will be printed on the control room event logging printer.
14) Right click menu options on SCADA software shall be designed to be disabled as required.
15) All requests and commands shall be via icons, whether menu linked or linked to equipment control actions. A permanent dynamic alarm banner shall be displayed at the bottom or top of each operator screen. Each control action will be routed through a series of confirmation routines.
16) The reports shall be available for printing in graph or tabular format. Dynamic trend displays shall also be available for all analogue flow, level and pressure values. Custom, as well as preconfigured reports and trends shall be available to a higher level of entry. A colour, A4/A3 size, screen dump printer shall be provided for graph and trend prints.
17) An operator help utility shall be provided, offering help linked to the particular action being carried out by the operator at that time. At least one help screen per screen page shall be available. This facility shall be preconfigured with an option for updating by operators, via a password entry.
18) The Application Server software shall be configurable to provide for the monitoring and control of all points, loops, and systems through graphic display screens and hard copy reports. These shall include:

- Parameter Displays for signal control
- Control Loop Status Displays
- Real Time and Historical Data Trend Displays
- Event Displays and Log Reports
- Alarm Displays and Log Reports
- Equipment Diagnostic Displays and Reports.

19) The system shall provide on-line diagnostics that display the current status and operation of the local area network and its nodes. The diagnostic display shall include the LAN adapter status for the machine showing the display, as well as the current number of messages, errors and retries.
20) The system shall conform to and take advantage of industry standards. These shall include, but not be limited to:

- ODBC

- OLE
- ActiveX
- COM/DCOM
- DDE and Advance DDE
- C programming language
- Visual Basic
- Microsoft Windows XP or the most current Operating System
- TCP/IP
- OPC
- XML

21) Display Facilities and screen/mimic refresh: The displays shall be user configurable, with the user being able to construct any desired symbol for display. Any display shall appear (excluding historical recall) within 1 seconds to 2 seconds of selection and the displayed data shall be updated from the database .Alarms shall typically appear within 3 seconds to 5 seconds of occurrence and within 1 second of being received into the central system database. Plant mimics shall display dynamic color details of flow rates and pressures, pump status, well levels, alarms, electrical power supplies and other general equipment status conditions. The plants mimics shall include animation to depict plant process operation, pump running station, media flow within the plant, levels in the tank, etc. The animation shall be designed such that the screen refresh rate shall not effected. The SCADA servers and workstations (engineering & operator) shall be suitably chosen to meet this requirement.

22) The Contractor shall configure all display pages as fully as possible. However, facility must be incorporated to permit easy construction and modification of the display pages, by using a standard library of shapes and symbols. The library shall be added to and modified by the user as required. The configuration shall be object orientated for ease of use.

23) The initial application software shall provide for the display pages listed below and any pages necessary for the system to function as a complete entity.

a) Mimic displays
b) Graphic displays.
c) Trend displays.
d) Alarm summary tables with date and time.
e) Event logs of past 72 hours with date and time.
f) Tabular display of data.
g) Inset windows showing an analogue trends may be mixed with mimic displays. In such a display the main mimic and inset trend shall all be live with automatic display updates.
h) Indexing of information and menus shall be presented in the form of active windows on the screen, while the mimics etc. are still available for view.
i) No display or function shall effect the logging/monitoring of data. It shall be possible for the master station terminal and auxiliary terminals to perform simultaneously, different tasks within the display.

Monitoring and Alarms

1) The operator shall be able to monitor all of the information at the workstation. He shall be able to view active equipment information by use of graphical and tabular displays.
2) In the event of an equipment alarm, the following shall occur at the master station:

a) Alarm message displayed in the alarm message area of the screen.
b) The audible alarm shall sound.
c) The appropriate Section of the display page shall change color and flash.
d) A full message shall be written on the alarm page.
e) The full alarm message shall be printed on the alarm printer.
f) The full alarm message shall be recorded, stored on disk and automatically archived.

3) The operator should be able to acknowledge the alarm by pressing an accept alarm key or icon. This action shall stop flashing of all associated alarm messages and displays. However the display shall remain in the alarm state fixed color to indicate an accepted alarm. When all outstanding alarms have been acknowledged the audible alarm shall be silenced.
4) Once the alarm has cleared, the messages and displays shall return to normal. The alarm message shall stay recorded on the event/alarm log and an alarm cleared message shall also be recorded.
5) If the alarm clears before being acknowledged the sequence of events shall continue as above except the message shall change to indicate a cleared alarm.

6) An audible alarm silence function shall be provided to enable an operator to silence the audible alarm without acknowledging all alarms. On occurrence of any subsequent alarm, the audible alarm shall sound.
7) Each signal within the configured system shall be capable of being assigned an alarm based on the following:

a) Four levels per analogue (Lo Lo, Hi Hi, Lo and Hi).
b) Rate of change.
c) Deviation from set point or other control parameter.

8) Alarms shall be time tagged to 1 second resolution at the I/O's.
9) A minimum of four alarm priorities shall be provided so that those requiring immediate attention may be separated from alarms of lower priority. An audible alarm shall sound for alarms requiring operator action.
10) Typical alarm assignments are as follows:

a) critical alarm - an alarm that requires immediate operator action
b) non critical alarm - an alarm that requires operator action but not necessarily immediate action
c) operator guide alarm - an alarm that provides information to the operator
d) event - a low priority condition which is recorded.

Data Archiving

Continuous process (analogue) data, digital event states, alarms and operator actions shall be archived to a removable media system. The archive media shall be sized to store logged analogue data, at a maximum sample rate of 15 minutes for a period of three months locally. Data recording shall be on dual media. The archive system shall generate an alarm when a file is 60% full.

Analogues will be stored at a rate selected by the operator in the range 1 second to 1 hour. The operator shall have the facility to select the way in which an analogue is stored.

The system will provide any combination of the following:

- Instantaneous value.
- Average value.
- Maximum value.
- Minimum value.
- Not stored.

Maximum, minimum and average values shall be calculated over a period set by the operator in the range 15 minutes to 24 hours, the default shall be 1 hour.

The logging of new data and reception of alarms must be carried out at the same time as the operator is viewing archived data. Any alarms received must be displayed as an overlay on the visual display unit.

The contractor shall submit the data archiving policy to be adopted as part of functional design specifications for review and approval. The same shall be demonstrated during the factory acceptance test and site acceptance test.

SCADA Screens/Mimics

The Contractor shall configure all the mimics to provide total detailed coverage of the monitoring and control of equipment as detailed in this specification. It is expected that display modifications will be required in the future and therefore the ability to change the displays without programming skills is essential.

Instrumentation shall be displayed using ISO standard symbols. For mimic configuration, it shall be possible to call up a library of standard symbols representing items (e.g. pumps, valves) and add new symbols to the library. Building mimics shall be simple and be achieved by using a mouse or tracker ball pointing device.

The mimic displays shall consist of the following pages on a minimum but not limited to:

a) A general diagram covering the entire Tertiary treatment plant any associated systems on a single screen with key data being displayed. The same shall be constituted as plant overview screen. The same shall be programmed with complete animation to depict the normal process operation and process media flow within the treatment system.

b) A general block diagram for each site or area of Site showing the equipment displayed on a series of single screens with key data
c) Mimic of the equipment and instrumentation connected to each IO module displayed on as many screens as necessary.
d) Individual process screens
e) PLC network monitoring screen
f) Communication interface with CWPS control system and other interfaces as required under this contract.
g) Individual vendor packaged PLC monitoring screen
h) Login screens, reports screen, security screen, overall TTP screen, etc.. Shall be configured.
i) Screens indicating the current status of each equipment, maintenance schedule/status, Run hours, set points for all equipment inclusive of vendor supplied systems
j) Complete operational screens shall be developed for TTP SCADA for vendor packaged system's, irrespective of the vendor system HMI screen supplied.

The SCADA software shall have the ability to limit the number of displays being opened simultaneously at any given point of time. The software shall be able to display at least three process screens/pop up screens simultaneously and shall be active screens.

Trend Displays

It shall be possible to plot dynamically updated real time data and archived data on a line graph, to represent analogue or digital information. Each graph shall be capable of displaying 8 plots overlaid on a graph of different colors and line texture. Next to the graph, there shall be a key relating each color to its function.

The horizontal axis shall be time based and user selectable in minutes, hours, days, weeks, for example, together with a start time.

The vertical axis shall be scaled as a percentage of range and be displayed in the colour of the selected reading. To avoid cluttering, the vertical axis scale shall be changed by selecting the individual display. The vertical axis shall be automatically scaled for each selected point, between limits entered by the user.

Actual values in engineering units shall be displayed by positioning a cursor at the desired point of the trend graph. The display of the data shall also be available in tabular form.

a) Manual Data Entry:

The system shall be provided with facility for entering data manually via the keyboard. This data will fall into two types:

a) Constants which will be changed infrequently. This data may have time and date associated with it.
b) Maintenance related comments.

b) Manually Corrected Data:

The system shall allow a person with authorized access to correct manually, erroneous data via the keyboard.

Reports

There shall be a real time spreadsheet facility supplied and installed by the Contractor. The users shall be able to transfer data from either the archive system or live data to the spreadsheet.

The user shall be able to produce daily, weekly, monthly and annual reports using any data and a mixture of formats (tables, graphs, summaries, spreadsheets). It shall be possible to generate reports, either automatically at predetermined intervals, or manually on demand by the Operator.

Typical reports on a minimum would be:

- Inlet and treated flow
- Process parameters
- Laboratory analysis shall be transferred to centralized SCADA system
- Real time data monitoring system report for both inlet & treated flow
- Failures of equipment.

- Analytical instrumentation parameters.
- Wet well and tank levels.
- Discharge pressures.
- Maintenance schedules.
- Power consumption
- Chemical consumption
- Process alarm conditions.
- Status of all vendor control packages

Profiling

From an average, typical or manually entered plot, it shall be possible to set an exception profile whereby readings within an upper and lower level are acceptable. Profiles shall be set graphically via OW.

The user may select for the system to alarm if the reading is outside the profile and highlight such exceptions as part of a report, thereby reducing the need to examine all data, to ensure acceptability. The number of exceptions shall be logged.

Data Manipulation:

It shall be possible to perform simple mathematical functions on any data, including the following functions:

- Addition
- Subtraction
- Multiplication
- Division
- Square root

It shall be possible to log, display or use in a control loop, the resultant data.

Database Query Facilities:

The system shall support the use of database relationships and wild card characters to provide database query facilities. It shall be possible for applications integration to configure queries easily and save them for future use.

Support of Dynamic Data Exchange (DDE) or Structured Query Language (SQL), to permit data exchange between the SCADA and external applications, including spread sheets and databases.

Data shall be presented in tabular format and contain any combination of fields from the main system database. It shall be possible to manipulate the data by specifying search and sort criteria to define data range limits.

Once a query table has been created, it shall be possible to store the configuration and initiate successive look-ups, using a point and shoot technique.

Downloading IO Configuration:

It shall be possible to download configuration to the IO's from the engineering work station and the Portable Programming Unit (Laptop).

Diagnostics:

The system shall have on-line diagnostic facilities to report system faults as they occur. A set of off-line diagnostic routines shall be supplied for more extensive fault diagnosis.

Security Access Levels:

The functions available on the system shall be fully flexible so as to allow users access levels to be customized by the system operator, to suit individual user requirements.

Access to management and engineer levels shall be restricted by user selectable passwords or key switch. The security systems shall be based on a set of privileges, which may be granted or denied to individual uses by the system operator.

Windows functionality of CNTRL+ALT+DEL shall be disabled. On SCADA startup, the system shall load and directly enter in the SCADA welcome home page .The design shall ensure that SCADA software development page shall not be accessed during the startup and only on appropriate login access, the same shall be accessible.

The security/access levels would be divided between Engineers, supervisors and operators.

The system shall be protected from un-authorized changes to the operating system and application programs.

The system shall prevent un-authorized users from re-booting the system or aborting or suspending system-related programs.

The system shall provide three levels of operator access to the system as a minimum, with the first level permitting access to viewing selected plant conditions as described below and the highest level intended for the system manager.

A mechanism shall be provided which prevents users operating at a lower level from accessing functions assigned to a higher level.

The system shall provide a password-protected, user log-on facility for definition of the user access level.
Passwords entered during the log-on process shall not be printed or displayed.

The software shall monitor the actions of the user currently logged on at each node and shall log the current user off after a definable extended period of no operator interaction with the system and produce a printed log-off message.

Logging off of the user shall not shut down the system or the SCADA mimic shall not log out. When the operator has logged off, the current SCADA mimic shall be visible for monitoring, but no action shall be possible until the operator has logged in back to the system.

System-generated log messages relating to operator actions, such as alarm acknowledgements or set-point changes, shall include the identification of the current logged-on user.

The Contractor shall provide the following defined user access levels as a minimum and additional levels as instructed by the Employer Representative:

1) Default Level:

The default level shall permit users to view all displays except those specifically assigned to a higher level of access.

2) Operator level:

The operator level shall permit authorized users to access default level activities in addition to the following:

a) Perform control actions;
b) Acknowledge alarms;
c) Enter or modify manually entered data for inclusion into reports.

3) System manager level:

The system manager level shall permit authorised users to access default level and operator level activities in addition to the following:

a) Modify alarm and control set points, dead bands and time delays;
b) Enter or modify historical data;
c) Add, delete or modify individual I/O points or point attributes;
d) Add, delete or modify field device configurations;

e) Create, delete or modify control algorithms;
f) Create, delete or modify graphic displays;
g) Create, delete or modify system reports;
h) Configure trend displays;
i) Access the operating system;
j) Assign access levels and user passwords;
k) Perform any other system maintenance function

Programming:

The method of programming will depend upon the Manufacturers system requirements. However, the following standards shall be followed:

a) All programs shall be written such that they lend themselves easily to alterations and additions.
b) Good programming practice shall be followed using structured programming techniques. All programs shall be tidy in format and logical to follow. Programs should be extensively annotated with comments and be self-documenting.
c) The system shall be supplied with programs that use a high level language.

Programme – Documentation:

As part of the requirements of this specification full documentation is required as below on a minimum:

a) Software user manuals
b) Database point allocation table
c) Complete program listing, flow charts for all sequences and control routines
d) Application software source code(applicable even for packaged control systems)
e) End user license agreements.

13.35 Control Room Furniture:

In addition to the SCADA system equipment, the Contractor shall provide industrial grade system consoles to complement or match both the colour and styling of the equipment. The Control room Furniture shall comply with relevant IEC standards for ergonomic design. System console shall be so designed to house all servers, workstations. Monitors, interface equipment with cables having back entry. Details and design of system consoles shall be submitted to the Engineer for approval. The system console shall be as per the approved vendor list provided elsewhere in this specification.

Typically, The Contractor shall provide five ergonomically designed swivel-type adjustable arm chairs with casters, two lockable cupboard with glass doors , three lockable File cabinets to store reports, storage of operating and maintenance manuals, drawings, logger paper, charts, disks and the like.

13.36 Spares for PLC & SCADA

Contractor shall provide all the services and supplies in accordance with approved procedures for handling of spare parts, which shall include arranging for their proper receipt, stacking and storage.

Spares for Commissioning & Start-up:

Contractor shall identify, define, procure, and supply construction, pre-commissioning, commissioning and start-up spares, special tools and handling gear for each item of equipment.
On a minimum, 1PLC CPU each (Hot standby PLC, standalone PLC used for TTP), 8 DI Module, 8 DO Module, 4 AI Module, 4 AO Module, 2 Nos of GPRS communication module, 2 no of managed Ethernet switches of each type installed ,30% fuses of each type and size installed shall be supplied.

The same shall be demonstrated during FAT and before commencement of SAT.

Spares list for 1st Year of Operation:

Contractor shall identify, define, procure, and supply construction, pre-commissioning, commissioning and start-up spares, special tools and handling gear for each item of equipment.
These items and quantities should be subject to BWSSB's approval. Upon completion of commissioning, contractor shall take inventory and ensure that spares for first year of operation as identified and defined are available on site.

Spares List for subsequent 2 Years of Operation:
Contractor shall identify, define and procure subsequent 2 years of operation, spare parts for each item of equipment.

Spares List for subsequent years of operation
Contractor shall identify, define and procure subsequent years of operation, spare parts for each item of equipment as necessary.

Note: Contractor to include Spare list during their bid submission based on the manufacturers recommendation for each item of equipment proposed.

13.37 SCADA Hardware Requirements

The system shall support hardware and software interconnectivity to other networks generally in accordance with the ISO Open System Interconnect 7 layer reference model.

Computers (Workstations):

1) The computer hardware shall be of current technology at the time of installation. Standard server stations, Standard PC technology with modern hardware, latest Windows operating system and data transmission over Industrial Ethernet must be used for the engineering workstations. It must be possible to install more than one engineering station in a system. Minimum 2 Tb capacity systems shall be supplied.

The engineering system must be an open system that, for example, permits the importing of project data from Microsoft Excel, SQL or from CAD/CAE programs. It must be possible to import/export messages to/from Excel and Access for simple processing. Removable memory media must also be provided for each workstation.

It must be possible to back up all database and configuration data both on removable media and on non-removable storage media without the system being offline.
Provision of redundant storage media must be possible for the configuration database. The specs for computer hardware shown are indicative only and minimum requirement to be supplied by the contractor.

2) All workstations, servers, communications equipment and peripherals shall be from reputed manufacturers, suitable for continuous operation and shall be the most currently available models at the time of construction, subject to approval. Adequate spare capacity shall be included to meet the specified requirements and future expansions. All workstations shall not be loaded more than 60% of their capacity. An alarm shall be generated when this capacity is exceeded.

3) The system shall support hardware and software interconnectivity to external Programmable Logic Controllers (PLC's) over an RS-232/RS-485 serial data link using Profibus / Modbus, Ethernet or similar protocol, subject to the approval of the Employer Representative.

Workstations:

Processor	Intel Xeon E3-1220 3.10 GHz v2
RAM	6GB (1 X 6GB) Non-ECC configurable Up to 32 GB 1600 MHz DDR3
Storage	2TB SATA HDD
ODD	DVDRW
Graphics	NVIDIA Quadro 2000 1Gb graphics with Dual Display Port, Dual-link DVI and supporting maximum resolution of 2560x1600

Monitor	32" LED Monitor Multiple input options – DisplayPort, DVI-D and V,Wide viewing angle with native resolution of 1680 x 1050; 16:10 Aspect ratio; 5ms response time ,ENERGY STAR 5.1 compliant, TCO certified Edge 1.1, and Mercury/Arsenic free glass
Ports	(4) USB 3.0 (Rear);(2) USB 2.0 (Front)
Ethernet	Gigabit ethernet
OS	64-bit Latest OS professional version (Minimum)
Warranty	Three-year(Extendable to7-years),next business day warranty including labor and parts, 24x7support

NAS Server (For Historian)

Specification	Minimum Requirement
CPU	Dual-coreIntel®2.4GHzProcessor
Memory	Systemmemory:4GBDDR3RAM
	Memory module pre-installed: 4 GBx1
	Total memory slots:4
	Memoryexpandableupto:32 GB (8GBx4)
Flash Memory	512MBDOM
Hard Drive	4 x 2 TB SATA6Gb/s
Hard Drive Tray	8xhot-swappableandlockabletray
LAN Port	2xGigabitRJ-45Ethernetport
	(Expandableupto6x1GbLAN or 4 x 10 Gb + 2 x 1GbLAN by installing optional dual-port 10 Gb and 1 Gb network card)
LED Indicators	Status,10GbE, LAN, E sata, hard drives
Form Factor	2U, Rackmount
Expansion Slot (PCI-E)	2

Analog Inputs	No. of channels (Twelve or Sixteen); At least two spare channels needed; A/D resolution – 16bits (0.003%),Full scale accuracy-+/-0.1% (@20deg.C) Input impedance – 100 Ohm,Differentialmoderejection66Db at 50/60Hz
Input voltage	10to30VDC (integrated switching supply)
Temperature	-40 to 70°C (-40 to 85°C storage)
Humidity	5% to 95% RH (non-condensing)
Mounting	DIN rail

Remote telemetry Unit (RTU):

Specification	**Requirement**
Dynamic memory (RAM) (program execution, dynamic variables and file system, etc.)	32 Megabytes or more
Program memory (Flash) (for Linux OS, program storage, and file system)	64 Megabytes or more
Data-log memory (RAM) (for data log and retained variables)	Battery-backed – Rechargeable Lithium. The contractor shall provide in his offer, the selection and sizing calculations with reference to the RTU regarding sufficiency of Memory and Processing power of RTU to handle all the specified functions, storage requirements, data-up date speeds, etc. shall be taken care of in the selection and sizing.
Battery-backup time and battery life	1year backup time and battery life of 10+years
Real-time clock	10Ms
Real-time clock	+/-15 seconds per month
Data log modes	Trending, alarm log, sequence of events, event initiated, client transfers, and others
IEC	Yes
Language support	At least two or more from Ladder logic, function chart, function block, instruction list, structured text, and flowchart

Cycle time	10 ms minimum (user settable)
Communication capabilities	Master, slave, peer to peer, report on exception
Communication	Ethernet (TCP/IP) and RS485(MODBUS)
Telemetry(built-in)	Built-in GPRS (with4G and compatible with 5G); Incase 5G is unavailable at this point of time, it shall be compatible to 5G in future with minimal downtime to the system operations and no extra cost to BWSSB.
CPU watchdog	CPU automatically resets if error is detected; status LED flashes error code
Ethernet Port	Network port:1 shielded RJ45connector with Isolation to1.5kV rms/ 1minute Message response time (typical) – 5ms Diagnostic LEDs–(speed and activity) Protocols supported–TCP/IP, ARP, UDP, ICMP, DHCP, Modbus/TCP
Serial Ports	Two numbers RS232 PortRJ45/ DB9, atl east one RS485Port with Screw termination (support for full-duplex and/or 2-wire half-duplex) Protocols – MODBUS ,Software, RTS-party (for radios and RS-485)
Discrete Inputs	No.of channels:Atleast12, with ON Voltage 9 to 30VDC, OFF Voltage 0 to 5VDC Input Resistance: 10K Ohms, Input Current @ 24V / 3 Ma
Discrete Outputs	No. of channels :Atleast8(10-30VDC) with Maximum Output per channel of 1amp Typical ON resistance:0.3ohms and Typical ON voltage (@1A) – 0.3VDC
Analog Inputs	No. of channels (Twelve or Sixteen); At least two spare channels needed; A/D resolution – 16bits (0.003%),Full scale accuracy-+/-0.1% (@20deg.C) Input impedance – 100 Ohm, Differential mode rejection 66Db at 50/60Hz
Input voltage	10to30VDC (integrated switching supply)
Temperature	-40 to 70°C (-40 to 85°C storage)
Humidity	5% to 95% RH (non-condensing)
Mounting	DIN rail

HMI / PANEL PC

Specification	**Requirement**
Front Bezel:	Aluminum w/IP65/NEMA4 rugged protection
LCD Panel:	Display size 16” colour or greater LCD.
	Brightness 350nits
	Resolution 1280 x 1024 pixels
	Viewing Angle80°/80°
	Display Size:16” minimum
Main System:	CPU LGA1155 socket 3rd &2nd Generation Intel®Core™i7/i5processor
	System Memory 2 x 204-pin DDR 3SO-DIMM max.upto16GB
	Storage 2 x 2.5” SATA HDD
	Drive1xbuilt-in slim DVD-RW (optional)
	Watchdog Timer 255 levels, 1~255sec.
Operating System:	Latest Windows .(Contractor shall submit compliance test report w.r.t various applications, functionality)
IO Connector:	3 x RS-232 (COM2-4)
	1 x RS-232/422/485 (COM 1)
	1 x RS-232 with 5V & 12V (COM 3)
	1 xDVI-D
	1 xVGA
	6 x USB 2.0(back)
	2 x USB 2.0(front)
	2 x 10/100/1000 Mbps Ethernet
	1 x Audio (Mic-in/Line-out)
Touch screen:	5-wire resistive type
	1million activations (typical) at a single point
Power Supply:	100 ~ 240VAC,270W
Dimensions:	469 mm (W) x 94.7 mm (D) x 380.8 mm(H)
Environment:	Operating Temperature: 0° ~ +45°C (+32°F ~+113°F)
	Storage Temperature: -20°C ~ +65°C (-4°F ~+149°F)
	Relative humidity:10~95%@40°C, non-considering

	Operating vibration: 1.0G, 5-500Hz, random
Processing and Memory	The contractor shall provide in his offer, the selection and sizing calculations with reference to the HMI regarding sufficiency of Memory and Processing power of HMI to handle all the specified functions, storage requirements, data-update speeds, etc. shall be taken care of in the selection and sizing.

DC Power Supplies

Specification	**Requirement**
Nominal input voltage	230VAC
Frequency	47 Hz to 63Hz
Input current	3.2 A typ. At 230VAC
Mains failure hold-up time	> 20 ms at 230VAC
Nominal output voltage	24VDC
Output current	10 A at 24VDC
Adjustment accuracy	1%
Degree of protection	IP20
Operational indication	LED green (24VDCo.k.),LED red(overload)
Type of mounting	DIN-rail mounting (DINEN50022)
Ambient	-10 °C to+70°C
Wire Connection	Cage Clamp
Type	SMPS, shielded metal case, with provision for earth

Intrinsic Safety Barriers

Specification	**Requirement**
Channels	Isolation type IS Barriers, DIN Rail mount
Type	DC version, positive polarity
Nominal resistance	300Ω
Fuse rating	50Ma
Working voltage	Max. 27 V , 26.5 V at 10 µA
Degree of protection	IEC60529
Ambient temperature	-20 ... 60 °C (-4 ... 140°F)
Storage	-25 ... 70 °C (-13 ... 158 °F)
Degree of protection	IP20

Mounting	Standard35mmDINmountingrail (EN60715:2001)
Group, category, type of protection, temperature class	II3GExNaIICT4Gc[deviceinzone2]
Directive94/9/EC	EN 60079-0:2009, EN 60079-11:2007, EN 61241-11:2006 , EN 60079-15:2010
IEC Ex approval	IEC Ex BAS09.0142

Surge Protection Barrier

Specification	Requirement
Channels	1-Channel
Rated voltage Un	≤30V
Rated current In	≤250mA
Leakage current	≤5μA
On-state voltage	≤45V
Nominal discharge current (8/20)In	10kA pe rcore,5kA per core(10x)
Max. surge current (8/20)Imax	20kA per core,10kA per core(1x)
Degree of protection	IEC60529
Ambient temperature	-30...80°C(-22...176°F)
Degree of protection	IP20
Mounting	DIN rail mount module
Group, category, type of protection, temperature class	Ex II 2(1)G Ex ia IICT6
Directive94/9/EC	EN60079-0:2006,EN60079-11:2007
IEC Ex approval	IECEx BAS14.0010X

ROUTER for 4G/5G (As applicable)

Specification	Requirement
	• Auto-switch fail over between primary and backup link

Important 4Gfeatures	• Multichannel-interface-processor (MIP) profile configuration
	• Remotely initiated data callback using voice
	• Remotely initiated data call back using Short Message Service (SMS)
	• Remote firmware upgrade over 4G/5G
	• Virtual diagnostic monitoring
	• Mobile Equipment Personalization (MEP) lock and unlock capabilities
	• SIM lock and unlock capabilities
Dual SIM support	• High reliability and cellular multi-homing support for HSPA and HSPA+ based networks
	• Dual SIM card socket; compliant with ISO-7816-2 (SIM mechanical)
	• Two Internal SIM Card Slots:
SMS	• Ability to send and receive SMS (maximum of 160 characters)
4G/5G network management and diagnostics	• In-band and out-of-band management using Telnet (Cisco IOS Software command-line interface [CLI])
	• Industry-standard 4G diagnostics and monitoring tools (QUALCOMM CDMA Air Interface Tester [CAIT] and Spirent Universal Diagnostic Monitor [UDM])
Included antenna	Two multiband swivel-mount dipole antennae (4G) and one extender (4G-AE010-R) to be included Routers.
LED indicators	• Received signal strength indication (RSSI) (green)
	• WLAN
	• WWAN
	• SIM status
	• 4G/5G service (green/amber)
	• SYS
	• ACT

IP and IP services features	• Routing Information Protocol Versions 1 and 2 (RIPv1 and RIPv2)
	• Generic routing encapsulation (GRE) and multipoint GRE (MGRE)
	• Standard 802.1d Spanning Tree Protocol
	• Layer 2 Tunneling Protocol (L2TP)
	• Layer 2 Tunneling Protocol Version 3 (L2TPv3)
	• Network Address Translation
	• Dynamic Host Configuration Protocol (DHCP) server, relay,
	and client
	• Dynamic Domain Name System (DNS)
	• DNS Proxy
	• DNS Spoofing
	• Access control lists (ACLs)
	• Ipv4 and Ipv6 Multicast
	• Open Shortest Path First (OSPF)
	• Border Gateway Protocol (BGP)
	• Performance Routing (PfR)
	• Enhanced Interior Gateway Routing Protocol (EIGRP)
	• Virtual Route Forwarding (VRF) Lite
	• Next Hop Resolution Protocol (NHRP)
	• Bidirectional Forwarding Detection (BFD)
	• Web Cache Communication Protocol (WCCP)
Switch features	• Auto Media Device In/Media Device Cross Over (MDI-MDX)
	• 8 802.1Q VLANs
	• MAC filtering
	• Switched Port Analyzer (SPAN)
	• Storm control

	• Smart ports
	• Secure MAC address
	• Internet Group Management Protocol Version 3 (IGMPv3) snooping
	• 802.1x
Security features	• Secure Sockets Layer (SSL) VPN for secure remote access
	• Hardware-accelerated DES, 3DES, AES 128, AES 192, and AES 256
	• Public-key-infrastructure (PKI) support
	• 20 Ip sec tunnels
	• Dynamic Multipoint VPN (DMVPN)
	• Tunnel-less Group Encrypted Transport VPN
	• Ip sec stateful failover
	• VRF-aware Ip sec
	• Ip sec over Ipv6
	• Adaptive control technology
	• Session Initiation Protocol (SIP) application layer gateway
	• Zone-Based Policy Firewall
	• Stateful inspection transparent firewall
	• Secure HTTP (HTTPS), FTP, and Telnet Authentication Proxy
	• Dynamic and static port security
	• Firewall stateful failover; VRF- aware firewall
	Content filtering:
	• Cisco IOS Software black and white lists
	Integrated threat control:
	• Intrusion prevention system (IPS)
	• Control Plane Policing
	• Flexible Packet Matching

	• Hierarchical QoS (HqoS)
Ipv6 features	• Ipv6 addressing architecture
	• Ipv6 name resolution
	• Ipv6 statistics
	• Ipv6 translation: Transport packets between Ipv6-only and Ipv4-only endpoints (NAT-PT)
	• Internet Control Message Protocol Version 6 (ICMPv6)
	• IPv6 DHCP
Memory	
DRAM	At least 512MB
Flash memory	At least 256MB
Interface Support:	
Console or auxiliary port	RJ-45: Single dual-purpose port, which provides direct connection to a console or external modem for management or backup access point
Mini-USB port(RSVD)	Mini-USB port to support remote 4G/5G diagnostics and monitoring tools (QUALCOMM CAIT and Spirent UDM)
WAN interfaces	• Wireless WAN with 3G,3.5Gand 3.7Gspeeds
	• 10/100/1000 Giga bit Ethernet port
LAN interfaces	• Four 10/100 Fast Ethernet ports
Standard safety certifications	• UL 60950-1, 2nd edition

Broadband Internet

Broadband internet services with high speed connectivity shall be supplied for connectivity with centralized SCADA center and for web connectivity. The most suitable package of broadband internet service provided by an Internet Service Provider (ISP) which suits the Client's requirement shall be utilized. The contractor shall enter in to SLA agreement to provide continuous fail safe services as required under this contract.

Fixed Line

For locations at where ISP is readily available, the technology which supports the broadband services shall be based on Digital Subscriber Line (DSL). The type of DSL utilized shall be of the Asymmetrical Digital Subscriber Line (ADSL) which shall allow simultaneous access to the net and usage of the telephone or fax line Certified ADSL modems shall be utilized. Splitter and micro filter shall be installed on the telephone or fax line to avoid interference.

Visual Display Unit (VDU)

1) Visual Display Units (VDU's) shall be color monitor monitor screens, capable of displaying information in alphanumeric, bar histogram, graphical and mimic diagram formats. Monitors shall simultaneously display a minimum of 256 colors, non-interlaced, low radiation, flat screen with no discernible flicker. Display of characters shall be legible and stable on a shadow mask tube, having a resolution of not less, so that 1024 by 768 pixels and a refresh rate of not less than 70 Hz. The units shall include all the necessary picture controls to adjust the sharpness, contrast and position of the image. LED VDUs shall be flat screen, minimum requirements: brightness 250 cd/m2, 500:1 contrast ratio, 1600 x 1200 pixels,
2) VDU's shall be 32 inch LED monitor Screens on a minimum.
3) VDU's shall be fitted with a power management system to reduce consumption upon detection of a stand-by signal from the PC.
4) Note: Each SCADA server, engineering and operator workstation, Historian system, CCTV system shall be provided with VDU units as described above.

Colour Multifunction Printer:

Color Multifunction printer shall be used for the production of color screen dumps and reports and shall have a sufficiently sized buffer memory such that system performance will not be degraded when the color printer is operational and comply with the following:

Printer Specification:

All-in-one functions	Print, copy, scan, fax, standalone scan-to email, photo card slots
Multitasking capability	Yes.
Paper Size	A3,A4
Print speed, black (normal quality mode)	Up to 21 ppm
Print speed, color (normal quality mode)	Up to 21 ppm
Print speed footnote	Exact speed varies depending on the system configuration, software program, and document complexity.
First page out (color)	As fast as 17.9 sec
Monthly duty cycle	Up to 40,000 pages
Footnote for duty cycle	Duty cycle is defined as the maximum number of pages per month of imaged output. This value provides a comparison of product robustness in relation to other LaserJet or Color LaserJet devices, and enables appropriate deployment of printers and MFPs to satisfy the demands of connected individuals or groups.
	Paper Heading:
Paper handling standard input	50 sheet multi-purpose tray 1, 250-sheet input trays 2 and 3, 50-sheet ADF

Paper handling standard output	150-sheet face-down output bin
Envelope capacity	Up to 30 envelopes
Envelope feeder	No
Duplex printing (printing on both sides of paper)	Automatic (standard)
Document finishing	Sheet fed
Media sizes, standard	Letter, legal, executive, envelopes (No. 10, Monarch)
Media sizes, custom	Tray 1: 3 x 5 to 8.5 x 14 in; Tray 2, Tray 3: 3.94 x 5.83 to 8.5 x 14 in
Media types	Paper (bond, brochure, coloured, glossy, letterhead, photo, plain, pre-printed, prepunched, recycled, rough), transparencies, labels, envelopes
Media weight	Tray 1: 16 to 47 lb (up to 58 lb with Color Laser glossy photo papers); tray 2, tray 3: 16 to 43 lb (up to 47 lb with postcards, up to 58 lb with Color Laser glossy photo papers)
Weight	71.2 lb
Processor speed	450 MHz
Memory, standard	160 MB
Memory, maximum	416 MB
	Scanner Specification:
Scanner type	Flatbed, ADF
Scan resolution, optical	Up to 1200 dpi
Bit depth	42-bit
Scan size, maximum (flatbed)	8.5 x 11.7 in
Scan size, maximum (ADF)	8.5 x 14 in
Scan speed (default)	Up to 15 ppm
Automatic paper sensor	No
	Copier Specification:
Copy speed (black, best quality, A4)	Up to 20 cpm
Copy speed black (best, letter)	Up to 20 cpm
Copy speed color (best, letter)	Up to 20 cpm
Copy resolution, black	Up to 600 x 600 dpi
Copy resolution, color	Up to 600 x 600 dpi
Copy reduce/enlarge settings	25 to 400%
Maximum number of copies	Up to 99 copies
	Fax Specification:
Faxing	Yes
Fax transmission speed (seconds per page)	3 sec per page

Fax memory	Up to 250 pages
Fax note	Based on standard ITU-T test image #1 at standard resolution. More complicated pages or higher resolution will take longer and use more memory.
Fax resolution, black (dots per inch)	Up to 203 x 196 dpi
Speed dials, maximum number	Up to 120 numbers
Auto redial	Yes
Fax delayed sending	Yes
Fax broadcast	119
Junk fax barrier	Yes
Polling	Yes (receive only)
Remote retrieval	No
Fax forwarding	Yes

13.38 Uninterruptible Power Supply (UPS) for Instrumentation, Control & Automation

The UPS shall be floor mounted; self-contained and metal clad and shall be suitable for supplying a non-linear load. It shall be possible to open the enclosure front door when the unit is in use without exposing any live contact to touch.

The complete UPS system shall be installed in a separate room in the administration building, with a separate room for batteries.

The UPS shall be an on-line type incorporating a six pulse rectifier and pulse width modulation inverter technology with microprocessor control. It shall incorporate a static bypass switch which shall operate in the event of UPS failure, overload or manual initiation in order to transfer the output supply to mains without disturbance to the output supply.

The UPS shall incorporate a dc under voltage trip circuit to electronically trip the UPS output in order to protect the batteries.

The noise level of the unit shall not exceed 60dB(A) at 1 m from the UPS cabinet.
The output of the inverter shall be a sine wave having less than 2% THD for linear loads and less than 4% for 50% non-linear load. It shall be suitable for load power factors 0.7 lag to 0.9 lead.

The unit shall have a dynamic response such that a 100% step load causes an output voltage transient of less than ± 4% with a recovery time of less than 4 ms.
For three phase output units the output voltage shall not vary by more than ± 1% for an unbalance of 10%.

The load crest factor shall not be less than 3:1.

The efficiency at full load and 0.8 power factor shall be greater than 88%.

The UPS System shall communicate the following status data to the plant SCADA system to monitor: (Note: To be demonstrated during FAT)

- UPS status
- UPS alarm conditions
- Battery capacity
- Bypass status
- Fault

The UPS shall provide a volt free contact output to indicate:

- warning, i.e. low battery capacity
- fault
- static bypass in use.

The UPS shall have an overload capacity of 150% for 30 seconds and shall be protected in the event of a short circuit of the output.

The batteries shall be housed, either within the UPS enclosure or within a separate matching battery cubicle suitable for location adjacent to the UPS. The UPS battery shall be located in a well ventilated area.

a) Technical Particulars:

Each UPS shall have the following features:

a) The UPS shall be stand alone, parallel redundant, true on line, based on advanced IGBT PWM technology with microprocessor based control, monitoring and fault diagnostics, static by pass switch and front access oriented layout.

b) Main Parameters:

1	Input Voltage	415V +10% -15 % A.C. Three phase 4 wires with Solidly earthed Neutral.
2	Symmetrical Short circuit level. Frequency	25kA 50Hz ± 5%
3	Output Voltage	240 ± 1% A.C, Three Phase 4 wire with Solidly Earthed Neutral.
4	Frequency Wave form	50Hz ± 5% True Sine Wave
5	Isolation	True on line with complete galvanic Isolation
6	Total harmonic Distribution	< 2% for linear load, < 3% for non-linear load
7	Over load Capacity	125% for 10min 150% for 10Sec
8	Transient Response	Remain within ± 1% and recover to 100% within ¼ Cycle
9	Crest factor	3 : 1
10	Duty	Continuous
11	Static by pass	to be provided
12	Efficiency Converter Inverter Overall	 > 94% > 93% > 87%
13	Max Ambient Temp and Relative Humidity	45°C & 100%
14	Cooling	Forced air
15	Acoustic Noise Level	<60db at 1.5m

16	Battery backup	120min for full load.(For TTP) 60 min on full load (For TTP)

c) The UPS shall be complete with Isolation transformer, Converter cum Changer, inverter, protections, indications, programming, microprocessor based monitoring and fault diagnostic system, communication facilities, redundant control power supplies, SMF battery, accessories and interconnecting Cables.

d) Constructional Features: The UPS shall be high quality CRCA sheet steel enclosed suitable for floor mounting. The sheet steel shall be of 2mm thick. All sheet parts shall undergo phosphating process to ensure anti rust conditioning and superior finish. Premier quality powder coating shall be applied. The degree of protection shall be IP 54. The UPS panel shall be provided with two earthing terminals. The final finish shall be Light Grey Semi Glossy Shade 631 of IS 5.

Converter cum Charger:

When normal AC supply is available, DC power for the inverter is fully supplied by the converter and the battery is kept under float charge. On main supply failure, the battery shall be automatically connected to the Inverter without interrupting the output voltage for critical load. Similarly on normalization of AC power, the DC load shall be transferred to the converter and battery shall be put on float charge without interruption at output side. The converter cum charger shall be designed to deliver the full load DC required by the inverter and charging of the battery. Battery charging shall be with float & boost mode selection with current limit.

1) Inverter:

The static inverter shall convert the power from the converter/battery into stable AC power which is supplied to load. The inverter shall be with the latest IGBT PWM technology with specially designed output transformer.

2) Battery Bank:

Batteries shall be 12V, SMF (sealed maintenance free) type. The Qty & AH of batteries shall be suitable for backup period of 120 minutes for full load for TTP and backup period of 60 minutes for full load for TTP .

The battery shall be rated to provide full load power for required backup time on AC power failure. After delivering this amount of power, the battery shall be suitable for recharging through converter cum charger on AC power restoration. The battery shall be mounted on a separate rack. The battery bank shall be complete with battery stand, interlinks and UPS to battery interconnecting cable.

The battery bank shall be installed in a separate room with good ventilation in the administration building.

3) Other features:

The other features of UPS shall be as follows:

i) Microprocessor based Control, monitoring and fault diagnostics.
ii) Comprehensive LED mimic and LED display with keypad Control to enable the following:
a) Date-time stamped event recording and logging in a non-volatile memory
b) Programming and Monitoring of various system parameters
c) Status indications and number of LCD digital meters.
iii) 100% Nonlinear local handling Capability with low distortion of less than 5% and high crest factor of 3:1
iv) RS 232c/ RS 485 interface port.
v) Front access layout.
vi) Inbuilt line chokes for main power supply.
vii) Indications:

- Mains 'ON'
- Converter 'ON'
- Inverter 'ON'

- Battery Low
- Over load
- Inverter Trip
- Charger Trip
- Output 'ON'

viii) Protections:

- Incomer MCCB with Overload & Short circuit releases
- Outgoing MCCB with Overload & Short circuit releases
- Battery MCCB with Overload & Short circuit releases
- Input under/over voltage
- Converter over voltage
- Battery Low
- Battery charging current limit
- Output under voltage
- Output over voltage
- Output over load
- Output short circuit
- Inverter over temp
- Single phase prevention

Alarm and trip conditions shall be separately enunciated.
The backup period shall be minimum 2 hr on full load.

Testing Requirements

The Contractor shall carry out specified tests as follows in addition to any tests stated or implied by the foregoing sections of this clause.

The tests shall be carried out on the fully assembled unit utilising the batteries that are to be supplied with the unit.

The Contractor shall demonstrate the following on a minimum:

- change-over from full load with mains present to full load on battery supply;
- carry out a discharge test on the system at full load and for the specified duty bridging time period;
- carry out recharge test after operation for the specified duty bridging time at full load. The UPS shall supply the full load during the recharge cycle.
- Demonstrate the full functioning of the PLC& SCADA system while running on UPS power.
- All Routine/acceptance tests as per relevant Indian / International standards shall be carried out in the presence of Employer / his Employer Representative

Quality Assurance/Quality Control (QA/QC)

QA/QVC shall comply with the Contract, with particular requirements specific to the equipment or service being provided as outlined below for PLC & SCADA systems and other equipment that shall comprise the instrumentation and automation system under this contract. The quality assurance/control procedures shall include, but not be limited to the following:

- Continuity and Wiring tests;
- Insulation and High Potential Testing;
- Complete functional test inclusive of calibration;
- Packaging and Shipping;
- Welding;
- Cleaning and Painting.

The quality assurance/quality control documentation shall include, but not be limited to the following:

- Material Certifications;

- Shop Test Reports;
- All other documentation required by applicable codes and standards.

13.39 SCADA Control Room design

Design Considerations

An ergonomic approach to the design of centralized SCADA monitoring center workstations and the layout of the control room shall contribute to achieving safety and performance objectives set for the centralized SCADA room.

Effective control room design shall consider safety and performance / aesthetic objectives and function to create workspaces that facilitate the complex interaction between operators, technology and the environment. Raised flooring, acoustic concerns, indirect lighting and the wellbeing, health and safety of each operator shall need to be addressed.

Operators in the control room shall work 24 hours a day, 7 days a week.

Control room design shall take into consideration room size, number of operators, viewing requirements and equipment. Operators shall be able to communicate with each other as well as have easy access to essential equipment. The height of the console shall be calculated so the shortest operator can see over the top of any workstation mounted electronics to remote monitor walls, control panels or displays and the clearance underneath the work surface should allow for the tallest operator to sit comfortably.

When designing the control room to address these and other concerns, the following steps shall be taken to ensure operator comfort and minimize fatigue:

- Test console layout with operators for “human tasks” including sequential task simulations.
- Develop workstation layouts designed around acceptable reach zones and visual limitations.
- Take into account maintenance requirements and removal of equipment from both the rear and front of the workstation.
- Provide ergonomic footrests where appropriate.
- Provide 24/7 chairs with full adjustment capabilities.
- Reduce excess heat and noise by locating electronics in an equipment room.
- In workstation dimensions, consider the full height and size range of the operators, utilizing height adjustable work surfaces where appropriate.

The SCADA control room shall be constructed to a high standard to provide a high profile feature and focal point for visitors to the TTP.

SCADA control room and associated areas shall be equipped with false flooring & false ceiling. The entire control room and associated areas shall be provided with air-conditioning systems (at least two nos. of 2 tonne air conditioners in the main control room & server area).

SCADA control room shall be designed to have maximum view of the plant and plant operation. The brick masonry works in the control room shall be replaced with full length glazed windows with access control system and CCTV system to prevent un-authorised access .No UPS system shall be installed in the control room. A separate UPS room ,separate battery room shall be provided in the administration building for the purpose.

The SCADA control room shall be equipped with false flooring to provide access for all cables. No cables shall be installed over the control room floor.

The SCADA control room shall be provided with air conditioning system .The temperature in any area of the control room shall not exceed 22deg C

1. Electrical & Earthing Requirements for SCADA control Room

SCADA Control room Power distribution system shall have redundancy at two levels. The electrical system shall be designed to incorporate spare capacity (Minimum 20%) at each distribution level. All wiring up to the SCADA Control room shall be laid in powder coated MS conduits / Aluminum raceway.

All power cables up to the SCADA Control room shall be PVC insulated type. All cables shall be armored cable type except where flexibility required does not permit use of armored cable.
Earthing system shall be as per IS – 3043.

Contractor shall design and implement anti- static EMI / RFI protection arrangement, wherever necessary.

The contractor shall design, engineer, supply/manufacture, test, erect, install, connect; commission and site test the Electrical Distribution System for any and all power requirements within the SCADA Control room facility. This shall include, but not be limited to UPS, Lighting system, ACDB system and input power to various sub systems of the Server/SCADA Control room like cooling units, alarm systems etc.

Design, engineering, supply, section, wiring, commissioning and testing of all systems are in the contractor scope. Contractor shall design, engineer, supply, commission and test the electrical system considering the various loads it has to cater to.

The technical specifications and the scope for various items provided herein need to be verified by the Contractor. Contractor's scope shall include end to end system that is designed and implemented according to various applicable standards / regulations and meets total requirement for the Server/SCADA Control room Facility.

Copper earth pit station as per IS - 3043 using 600 X 600 X 3 mm copper earth plate complete with accessories and hinged cover shall be provided by the Contractor. Another earthing system shall be extended for equipment body earthing of SCADA control room, using 25 X 3 mmGI strip. Two Earthing pits shall be provided for UPS Earthing, which will be interconnected, and same grid will join the building-earthing grid at only one point. Earthing System shall be designed & maintained considering personnel safety and noise-resistant electronic environments by providing equi-potential bonding with earth resistance of less than 3 ohm. Contractor shall design, supply and implement the most efficient and safe earthing system considering the types of load, fault conditions, cross current circulation, spikes, circulating current due to potential differences, etc.

The earthing system implemented shall ensure safety of people and systems under all conditions. Earth fault protection shall be designed and implemented by the Contractor for all loads

2. Fire Alarm System

The contractor scope of work shall include on a minimum, design, engineering, supply and installation & commissioning of Fire Alarm System suitable for control room and all ancillary facilities area.
Fire Alarm System (FAS) shall be designed to detect & suppress the incipient fires and generates audio/ visual alarms in case of fire. The system shall consist of automatic fire detectors and manual call point & break glass units. Automatic fire detector shall work on principle of sensing the smoke, heat or infrared rays.

Detector shall be provided in control room and various location in the administration building. Manual call point shall be provided at exit doors/ routes of control room. Number of detectors and manual call point shall be decided as per guideline and codes.

Fire alarm system shall be microprocessor based fire alarm system and shall have addressable type field devices. It shall comprise following equipment's used in conjunction with addressable automatic detectors & and addressable MCPs.

1. Multi loop Data Gathering Fire Alarm Panel (DGFAPs).
2. Sirens & Starters, Hooters, exit signs.
3. Interface with other systems thru Dual redundant data highway with complete network hardware.

System shall be modular and facilitate future extension up to 20%. Redundancy shall be provided at Processor, communication, power supply level. Fire alarm logic shall be programmable type. Minimum number of detectors/ MCPs/ addressable devices in single loop shall be 60 nos. Conductor size of loop cable shall be 1.5 sq. mm copper. All field devices like detectors, MCP shall be addressable type. Fire alarm system shall be interfaced with Fire extinguishing system.

3. Fire Extinguishing System

Design, engineering, supply and installation commissioning, puff test, guaranteeing of total flooding (above false flooring + control room + below false flooring) clean agent Fire Extinguishing system for Fire Protection. Clean agent to be considered is HFC227ea, HFC-125, IG-541, IG-100, , IG-55 and IG-01 as per NFPA-2001 for fire protection.

All equipment's shall be approved by UL/FM/Vds/ LPC and TAC accredited agency. Cylinders along with cylinder valve shall be seamless and PESO approved. Clean agent system to be provided shall meet the requirement of NFPA 2001 (Latest).

The system shall include electrically actuated automatic clean agent Fire extinguishing system complete with filled up clean agent cylinders, cylinder rack, manifold, pressure reducing devices, cylinder valves, directional valves, pipes, discharge nozzles, bracket supports, hangers and such other fittings necessary for complete installation of system including necessary civil and mechanical work to complete the above work.

System shall be in operation in following modes

1. Automatically due to fire detection in protected area.
2. Operation of manual release push button located adjacent to protected area.
3. By operating manual lever provided on electrical/ manual control head on pilot cylinder
4. By push button actuation at clean agent control panel.

The system shall include electrically actuated automatic clean agent Fire extinguishing system complete with filled up clean agent cylinders, cylinder rack, manifold, pressure reducing devices, cylinder valves, directional valves, pipes, discharge nozzles, bracket supports, hangers and such other fittings necessary for complete installation of system including necessary civil and mechanical work to complete the above work.

The clean agent shall be discharged / actuated automatically after an adjustable time delay based on the detection signal received. The delay shall be minimum 30 seconds; however it shall be adjustable from 30 to 120 sec. Local control panel of control agent shall be equipped with Hooter. It will operate once gas is released.

4. False flooring:

Finished height of Access floor up to 450mm Raised flooring shall be provided.

a. The raised floor must be capable of withstanding a uniform load of 1,220 kg/m2 with a maximum deflection of 2.5 mm.
b. The recommended panel size for the raised floor is 610 mm square. These panels must be easily removable to facilitate access to the under-floor area. Special weather coating on back side of the tiles to be provided.
c. The raised floor must be level within +3.2 mm overall and within +1.6 mm in any 3.05 m (10 ft) distance.
d. Fire resistance of floor material must comply with more stringent, local regulations. It should be totally fire proof.
e. The metallic structure of the raised floor must be electrically bonded to the ground to minimize static buildup. The floor panels must have conductive contact with either the framing, the pedestals, or both for positive electrical grounding.
f. Panel surfaces must be high-pressure laminate. Do not use carpeting. Use material that is both dust and crack resistant. The material must withstand movement of heavy equipment on casters and must resist the buildup of static electricity. Cleaning products containing ammonia must not be used.
g. All cable openings in floor panels must have plastic edging to prevent damage to cables
h. Provide adequate drainage to ensure that no moisture accumulates in the recessed area.

Following provisions for the computer system between the raised floor and the primary floor: shall be provided:

- AC power distribution for the computer system
- Input/output cables.
- Air ducts or passages for cooling air
- Cable ducts

Clearance between the raised floor and the primary floor is 450 mm.

i. The cables are to be routed along the under floor and brought up to the cabinet locations prior to placing the cabinets.
j. Ensure that at least 102 mm (4 in.) of free space exists between the top of the under-floor cables and the raised floor. Route the cables so that excessive buildup does not occur in any local area. Cables routed under the floor that are to connect to electronic equipment must be routed so that excessive strain does not occur on the connector due to inadequate space for bent radius of the cable. In the case of the large diameter input/output cables for peripheral equipment, provide a minimum bend radius of 212 mm (6 in.). All cables are to be routed at 90 degree angles. Power and signal cables must be separated by 150 to 300 mm to minimize noise interference.
k. Matching/approved profiles to be provided.

5. <u>Industrial system console for SCADA control room:</u>

The Industrial system console solution shall be capable of performing 24X7 operations under the specified environmental condition. It shall conform to high standard of engineering as mentioned in the document; meeting the specified codes, designs and standards. All the certificates and reports mentioned below shall be submitted as part of datasheet submission. Entire system console shall be Green guard Gold and UL

certified. The system console shall be sized to accommodate the complete SCADA system and its ancillaries inclusive of but not limited to the following:

1. Redundant SCADA servers
2. Operator and engineering work stations
3. Historian stations
4. CCTV stations
5. Managed Ethernet switches
6. Online printers
7. Other ancillaries

The entire Industrial system consoles shall be warranted for minimum five years against any manufacturing defect.

The Color scheme of the system console shall be as per BWSSB requirements and shall be decided during detailed engineering.

Vendor Qualification criteria for design and supply of Industrial system console:

The agency which shall design, supply, install and commission the industrial system console equipment, on a minimum**,** shall be operating under an accredited ISO 9001:2015 system, with a minimum of 10 years' experience of having designed, supplying and installation of system console. The agency shall have proven track record of supplying similar console as required under this contract, to at least five control room projects. The agency shall have In-house metal manufacturing & automatic Powder Coating Plant.

Minimum Design Criteria for System Console:

Structure: -

Shall be made of heavy duty Extruded Vertical and Horizontal Aluminium profiles of HE9WP grade. The Extrusions shall be duly powder coated with 40+ micron over all surfaces.

To allow future extension and expansion, a weld free system shall be proposed. Interconnecting joints shall not be visible. The structure shall allow easy assembly of Hinged Shutters, Slat wall, Gland Plate, Monitor arms in extremely rigid manner.

Industrial system console shall be Seismic Zone 2 tested and certified with monitor mounted on monitor arms of the console. Seismic test report of bare Industrial system console shall be deemed unacceptable. Test report with images of Industrial system console seismic test should be enclosed along with the datasheet submission.

Table top: -

The material of the working surface shall be minimum 25 mm thick MDF with High Pressure ANSI/NEMA LD3 certified scratch-resistant Laminate.

Front Edge: - shall be UL Certified design with modular Polyurethane (PU) Edge. High density Poly Urethane Foam moulded on industrial grade aluminium core to form 50mm deep tapered edge shall be installed on worktop. UL Certificate to be enclosed along with datasheet submission.

Slat Wall shall be made of minimum 2mm thick Extruded Aluminum (HE9WP aluminum alloy) and designed in such a way that no joints or gaps are visible in the entire width of the console. The console should be UL Listed and certificate shall be submitted along with datasheet submission.

UL Certified design feature on Monitor Arm Assembly shall have auto-lock, push & add/remove die-cast aluminum extendible arms of 150mm each with tool less addition/deletion feature to cater future requirements.

Shutters & Side Legs: - Front, back shutters shall be of minimum 18 mm Laminated MDF Board with premium finish. Side leg shall be of 25mm of the same finish. Hinges shall have lifetime warranty against manufacturing defects. Warranty certificate shall be submitted along with the datasheet submission.

Cable Trays and Wiring: - The control system console shall be designed with vertical and horizontal cable trays to allow for continuous cable management between the cabinets. Wire shall be routed into the cabinet through gland plate.

Hardware: - All bolts shall be of SS material to avoid rust due to environment. Remaining hardware shall be Nickel Plated with RoHS certificate.

13.40 Inspection & Testing Requirements for Instrumentation, Control and Automation equipment, other related equipment as required under specifications:

A. Inspection and Testing Requirements for Instrumentation works

1. Inspection, Testing and Setting to Work — General

Each item of plant shall be subjected to the manufacturer's own tests which shall be certified. Each item of plant and its installation shall be subject to inspection and testing at the place of manufacture. The Contractor shall be responsible for the provision of all necessary test equipment. The Contractor shall demonstrate to the Engineer, the correct operation of any item of plant and the Engineer may witness any test. Tests which, in the opinion of the Engineer, were failed or not performed correctly shall be repeated.

Before any test is made, the Contractor shall submit to the Engineer a full list of test equipment to be used. Each item of test equipment shall have a standard of accuracy better than that stated by the manufacturer of the item to be tested. The Contractor shall provide evidence of the condition and performance of any item of test equipment, in the form of test certificates issued by an appropriate authority independent of the Contractor and manufacturer, or as otherwise directed by the Engineer. Test equipment shall be checked frequently during the period of the tests.

The Contractor's staff responsible for supervising and carrying out tests shall be fully conversant with the various items of equipment of other manufacturers and if necessary the Contractor shall arrange for his personnel to attend suitable training courses on his own expense. The contractor has to get approval from the client's representative for the training personnel to be employed by the contractor.

Any fault or shortcoming found during any inspection or test shall be rectified to the satisfaction of the Engineer before proceeding with further inspection or testing of that item. Any circuit previously tested, which may have been affected by the rectification work, shall be re-tested.

2. Preliminary Inspection and Testing at the Place of Manufacture

Field Instruments and Analytical Instruments

After the successful completion of the manufacturer's own inspection and testing of instruments to be supplied under the Contract, complete functional tests inclusive of calibration checks shall be carried out in the presence of the Engineer, engineer's representative and the Contractor at the manufacturer's factory where the instruments have been manufactured. Such tests shall include a demonstration that an increase

or decrease of the measured value at several points over the full range of the instrument produces a corresponding increase or decrease in the instrument output signal. These tests shall include checks on the specified accuracy of the instrument at all points. Complete functional testing of all instruments (Field instrumentation inclusive of all Analytical instrumentation, lab equipment, Online Real Time Multi Parameters Continuous Monitoring System for Influent and Treated water Parameters, Auto samplers, LED screen display system, wireless communication equipment, etc, covering all instruments and related equipment (Junction box, local control panels, all cables, cable trays)

3. Instrument panels, enclosures and mounting boards

The manufacturer shall not present instrument panels, enclosures, junction boxes and mounting boards (assemblies) for inspection and testing until the manufacturer's own tests and inspection has been completed. A preliminary inspection and test of these assemblies shall then be witnessed by the Engineer, engineer's representative. The Contractor shall give not less than 15 days' notice in writing that he has completed his tests and inspection and is ready for the witnessed tests and inspection. Where this notice period is different in the Conditions of Contract this shall take precedent.

The witnessed inspection and testing shall include the following on a minimum:

a. Complete functional testing of the instrument inclusive of calibration and sampling system (applicable for all field and analytical instruments, Online Real Time Multi Parameters Continuous Monitoring System for Influent and Treated water Parameters, Auto samplers):
b. A visual inspection of the panel assembly to show that the design, construction and finish are satisfactory and in accordance with the Specification;
c. A check that equipment is securely mounted, accessible for removal or calibration without damage to or undue disturbance of other components, wiring or piping;
d. That all engraving and labels are correctly positioned, fixed and designated in accordance with the Specification;
e. Panel power-distribution circuits have the correct breaker/fuse rating coordination and designation;
f. Power-isolation facilities meet the Specification;
g. The main incoming supply voltage, frequency and/or pneumatic supply pressure is within the required limits, these being checked at the beginning and end of the test and the results recorded on test certificates;
h. The output of all power supply units again at the beginning and end of the testing with results being recorded;
i. The power supply voltage or air pressure of all component instruments of the assembly(s), these voltages/pressures being recorded on the test certificate;
j. The insulation resistance of all circuits except sensitive electronic equipment which is liable to damage by application of the test voltage, such circuits being disconnected before making the insulation resistance tests and these tests being carried out in accordance with IEE Wiring Regulations;
k. That the clean earth bar is isolated from main frame of the panel. Internal lighting and anti-condensation heaters and associated thermostats, isolators, limit switches and wiring shall be checked for compliance with the Specification. Spare capacity within the panel(s) shall be checked to see that it complies with the Specification. This shall include future equipment space, spare terminals, space in wiring trunking and provision for additional cable entry.

4. Functional Testing at the OEM factory where the equipment has been manufactured

General requirements

Once the preliminary inspection and testing is complete to the satisfaction of the Engineer, functional testing shall commence in the presence of the employer and employer's representative for 100% quantity of all equipment. The purpose of the functional tests are to demonstrate that all instruments and analytical

instruments, lab equipment, Online Real Time Multi Parameters Continuous Monitoring System for Influent and Treated water Parameters, Auto samplers, LED screen display system, wireless communication equipment, etc, covering all instruments and related equipment (Junction box, local control panels, all cables, cable trays), panels' enclosures and mounting boards (assemblies),sampling system conform to requirements of the Specification. Functional testing on a minimum shall include, calibration check as per established international standards, transmitter function check, error reporting, alarm functions, communication check with external third party devices, etc.

Not less than 30 days before the commencement of functional tests, the Contractor shall submit to the Engineer, for approval, two copies of comprehensive test procedural documents detailing each test to be carried out. The document shall include results forms on which the results of each test will be entered. The forms shall include spaces for numerical values, where necessary, and witness signatures. All applicable drawings and data shall be provided at the place of inspection by the Contractor.
The Contractor shall provide all test instruments and equipment necessary to test the assemblies in their entirety.
The following is a typical list of the equipment required:
• Switch boxes;
• Indicator light boxes;
• Analogue signal sources;
• Dummy loads;
• Meters;
• Simulators;
• Desk-top computers;
• Programmers for PLC or outstations;
• Insulation test equipment.

5. Quality Assurance/Quality Control (QA/QC/QAP)

QA/QC shall comply with the Contract, with particular requirements specific to the equipment or service being provided as outlined below for ICA system and in full compliance to clause 16.35, sub clause-1,2,3 & 4, as detailed in above specifications. The quality assurance/control procedures shall include, but not be limited to the following:

- Continuity and Wiring tests;
- Calibration check:
- complete functional testing of equipment along with sampling system(as applicable):
- Insulation and High Potential Testing;
- Packaging and Shipping;
- Welding;
- Cleaning and Painting.

The quality assurance/quality control documentation shall include, but not be limited to the following:

- Material Certifications;
- Shop Test Reports;

All other documentation required by applicable codes and standards.

B. Inspection and Testing Requirements for Control &Automation works

a) Factory Acceptance Test (FAT)

The Contractor shall conduct a full programme of tests of the PLC & SCADA system at the Contractor's testing facility in the presence of the Engineer to verify that all features of the system have been provided, are operating correctly and are in full compliance with the Specification. Unless otherwise specified or

agreed by the Engineer, the entire PLC & SCADA system shall be assembled and tested together as an integrated system, including all master station equipment, all operators' consoles, all outstations and telemetry equipment all instrumentation panels and uninterruptible power supplies included in this Specification. The scheduled date for the factory acceptance test shall be as agreed by the Contractor and the Engineer at least four weeks before the test.

The PLC and SCADA system shall be conducted as one complete system FAT only. No separate FAT for PLC and separate FAT for SCADA system shall be conducted. Contractor to note the importance of this clause.

Not less than one month before the scheduled factory acceptance test, the Contractor shall submit to the Engineer for approval two copies of a comprehensive manual detailing each test to be conducted. The manual shall include a results form on which the results of each test will be entered, including spaces for numerical values where appropriate and witness signatures.

Not less than 21 days before the scheduled factory acceptance test, the Contractor shall submit the internal completed FAT test reports to the Engineer as per contract requirements, which has been witnessed and signed by the contractor representative and that, in the opinion of the Contractor, the system exhibits stable operation and is ready for the formal factory acceptance test by the employer and the employer's representative.

The factory acceptance test will be considered successfully completed only when the system has successfully passed all factory tests as detailed in the FAT procedure and Functional design specifications. The system shall not be delivered to Site until the successful completion of the factory acceptance test is certified by the Engineer. Delay in the delivery of the system due to failure of the factory acceptance test shall not constitute an unavoidable delay. If the system fails the factory acceptance test, the test shall be extended or rescheduled at the discretion of the Engineer.

All hardware to be used in the testing of the system shall have passed an agreed preliminary hardware performance test to ensure known hardware operability before software testing begins.

After successful completion of the factory acceptance test, no software changes shall be made to the system without written authorisation by the Engineer. Any changes to the system which effect the system software documentation, such as input scale modifications or changes to the control logic, shall be entered into the system documentation before delivery of the system to Site.

The entire cost of the complete FAT and any other required testing(interoperability, site visits etc..), including reasonable per diem expenses to cover meals, lodging, transport and similar expenses for all BWSSB& employers representative personnel attending the tests, shall be the responsibility of the Contractor/ system supplier and shall be included in the contract price.

b) Factory Acceptance Test Procedures

1) General

The scope of the tests shall include the proving of every aspect of hardware and software operation and functions as detailed below.

2) Hardware tests

(a) Verify the correct inventory of hardware including cables and printed circuit boards;
(b) Demonstrate that all spare-memory, disk-capacity and system-expansion requirements have been met;

(c) Demonstrate all hardware and software diagnostics;
(d) Verify all power supply voltages are within tolerance;
(e) Verify proper earth connections and isolation of instrumentation earth for all equipment;
(f) Demonstrate operation of test simulation and indication equipment and its Suitability for adequate functional testing of all system functions.

3) Software tests

(a) Demonstrate the editing of all system parameters including set-points, timers and the like;
(b) Demonstrate system configuration capabilities including the addition and deletion of input and output points, outstations, and all data base parameters;
(c) Demonstrate the addition, deletion and modification of mimic displays and report formats;
(d) Complete control philosophy with all interlocks shall be demonstrated
(e) Historian data check

4) Functional tests

The functional tests shall verify proper operation of every specified system function as an integrated system. These tests shall be conducted in conjunction with functional tests of instrumentation and control panels as specified elsewhere. All failures or discrepancies found shall be documented in the test manual.

Following a failure of any functional test, should software or hardware modifications be required it shall be the decision of the Engineer whether the factory acceptance test is to continue, re-start or be aborted. If testing is allowed to continue, any changes which are required shall be described in a system modification document, signed by both Contractor and Engineer and be incorporated into the final factory acceptance test documentation. The failed test shall be re-conducted and the Engineer may require the retest of functions which may be affected by the modification.
The functional tests shall include, as a minimum, the following:

(a) Demonstration that the system meets the requirements of the Specification for response time and speed of screen update
(b) Verification of the accuracy of all analogue input points in the system. The procedure shall include applying the appropriate signal to each analogue input at a minimum of three points within the range of the input, checking for expected numerical results, and verifying appropriate update of related mimic displays. Proper sensing and action by the system to high and low out-of-range inputs shall also be verified
(c) Verification of the proper logic sense, pulse accumulation and rate computation where appropriate, of all digital inputs and verifying appropriate update of related mimic displays;
(e) Verification of all control and sequencing operations and proper operation of all digital and analogue outputs. The procedure shall include simulation of all related process variables for both normal and abnormal conditions, including instrument and component failure, and demonstration of fail-safe response of the system. System outputs shall be indicated with appropriate lamps and indicators;
(f) Simulation of outstation communications errors and failures and demonstration of error detection and handling, failure detection and handling, and appropriate changes to control actions as designed and specified;
(g) Verification of fault detection and diagnostics by inducing a sufficient variety of fault conditions in the system to ensure that detection processes and fail-safe operation are adequately tested;
(h) Demonstration of proper operation of all mimic displays, help pages, reports, operator procedures and historical data accumulation;
(j) Demonstration of proper operation of all outstations following a simulated master station central processor failure;

(k) Demonstration of proper operation of all equipment during both a system wide or isolated power failure, and following power restoration. The procedure shall include the demonstration of battery backup of both master station and outstation for the full length of time specified, and proper operation of power fail, low voltage warning and all associated alarms.

5) Reliability test

After successful completion of the functional tests a 48-hour continuous run of the system shall be performed. The test shall be passed if no system function is lost or no hardware or software failure occurs. Hardware failure is defined for this test as the loss of a major component such as the computer, an outstation, a VDU or a peripheral device. Non-repetitive mechanical failures of loggers, push-buttons and the like are excluded.

During this test, the system shall be exercised with simulated inputs and conditions in a manner which approximates the on-site operational environment. Unstructured testing by the Engineer shall be included during this test. Upon any system failure during this period, it shall be the decision of the Engineer whether the reliability test is to continue or be aborted. If testing is allowed to continue any changes to the system which are required shall be described in a system-modification document, signed by both Contractor and Engineer and the document shall be incorporated into the final factory acceptance test documentation.

c) Factory acceptance test documentation

As a minimum, the following information shall be included in the factory Acceptance test manual for each test:
• Test identification number;
• Test name and description;
• List of all equipment to be tested including any special test equipment required;
• Description of the test procedure broken down into logical steps, complete control philosophy check;
• Description of the expected system response verifying the completion of each logical step;
• Space for recording the results of the test and the time and date of the test;
• Space for signatures of the Contractor and the Engineer.
In addition, the Contractor shall provide a method for recording and tracing all problems, discrepancies, queries and suggestions regarding the system and software, and for formalised control of any modifications to the system.

d) Pre-commissioning tests

The Contractor shall perform pre-commissioning, or preliminary, testing of the SCADA system in accordance with that specified for instrumentation. The purpose of pre-commissioning tests is to confirm readiness of the system for commissioning.

The scope of pre-commissioning tests shall be generally as specified for factory acceptance tests but real field inputs and final control elements shall be used wherever practical to provide inputs to the system and to confirm proper outputs.

Where this is impractical, simulation signals shall be injected as near as possible to their ultimate sources so as to include in the tests as much of the cabling system as possible.

Each process system shall be set to work under manual control and the system tested to confirm proper operation. After proper operation of manual control mode has been verified, tests of automatic controls of each process system shall be conducted wherever practical.

e) Site Acceptance Tests (SAT)

The Contractor shall submit all relevant draft operating manuals for the PLC & SCADA System to the Engineer for approval prior to commissioning tests. Any faults or failures of the system detected during the previous tests shall be noted and corrected to the satisfaction of the Engineer before commissioning is allowed to commence.

As part of commissioning the PLC & SCADA system(complete ICA system inclusive Field instrumentation , Analytical instrumentation, lab equipment, Online Real Time Multi Parameters Continuous Monitoring System for Influent and Treated water Parameters, Auto samplers, LED screen display system, wireless communication equipment, etc, covering all instruments and related equipment (Junction box, local control panels,etc) shall be tested for availability for a continuous period of ninety days. The control and instrumentation system shall be subjected to SAT only after the complete plant electro-mechanical and ICA works have been completed and tested to perform as per contract requirements and both manual and auto mode of operations has been completely tested and found to be as per contract requirements. During this period, the system will perform the normal functions according to the procedures described in the SAT documentation approved by the Engineer.
The system shall have passed the SAT if all major components have been free from fault or failure and exhibit full error-free functionality for 100 % of the total duration of the test. Major components include all master station equipment, outstations, communications facilities and instrument panel components, excluding push-buttons, switches and lamps and any equipment not supplied by the Contractor. If the system fails to meet the above criteria, the SAT period shall be reinitiated further for a period of thirty days, till such time the complete system exhibit full error-free functionality for 100 % of the total duration of the test.

During SAT, no modifications to the system shall be made by the Contractor without the written approval of the Engineer. Erroneous functioning which requires software modifications or re-configuration to correct, other than set-point or parameter changes, shall constitute a failure of the availability test. Any changes to the system which are required and approved shall be described in a system-modification document, signed by both Contractor and Engineer and the document shall be incorporated into the final test documentation. The test shall be restarted after corrections have been made.

13.41 Training Requirements for Instrumentation, control and Automation works

A. Before Conduction of Site Acceptance Test(SAT)

The system supplier shall conduct training courses for personnel selected by BWSSB. Training shall be conducted by personnel employed by the Contractor/ system supplier familiar with the system supplied and who have experience and training in developing and implementing instructional courses.

Training shall be conducted for a minimum period of two (days) for at least five BWSSB personnel on site ,by the system suppliers (Field instrumentation, Analytical instrumentation, Online Real Time Multi Parameters Continuous Monitoring System for Influent and Treated water Parameters,CCTV systems, Process equipment suppliers (vendor supplied systems), Plant operations, Control & Automation systems, Laboratory systems, etc

The entire cost of the complete training programme, including reasonable per diem expenses to cover meals, lodging, transport and similar expenses for all BWSSB personnel attending the training program, shall be the responsibility of the Contractor/ system supplier and shall be included in the contract price.

The Contractor/ system supplier shall submit information on the training programe for approval, 45 days prior to training program. This submittal shall include a course outline; time required, course schedule, sample workbook and instructor qualification information for each level.

The Contractor/ system supplier shall make a workbook on each course available to every person taking the courses listed herein. The workbook shall be of sufficient detail so that, at a later date, a trainee could review in detail the major topics of the course.

The training times shall be scheduled by the BWSSB in advance with the Contractor/ system supplier so as not to disrupt the BWSSB's/contractor ability to operate the plant.

B. After Conduction of Site Acceptance Test(SAT)

Training shall be provided for ten (10) of the BWSSB personnel at the TTP facility on operations and maintenance of all system components. The training program shall be divided into two segments and shall consist of at least 5 (five) working days, each of 8 (eight) hours duration. This shall include (Field instrumentation, Analytical instrumentation, Process equipment suppliers (vendor supplied systems), Plant operations, Control & Automation systems, Laboratory systems, etc

The maintenance training program shall be developed for personnel that have electronics maintenance and repair experience and a general knowledge of computer systems, but shall not assume any familiarity with the specific hardware furnished.

As a minimum, the following subjects shall be covered:

- System Architecture and Layout
- Hardware Components
- Module Switch Settings (Configuration Switches)
- I/O Modules
- Power Supplies
- Data Highway:
- Programmer connection
- IOP programming and diagnostic techniques
- Battery replacement and recharging
- PC and workstation familiarization and maintenance:
- Troubleshooting
- Disassembly
- Cleaning
- Component Replacement
- Re-assembly
- The operation training programme shall include the following topics:
- Power-up, bootstrapping and shutdown of all hardware devices
- Interpretation of all standard displays
- Appropriate actions for software and hardware error occurrences
- Use of operator interface displays and keyboards
- Use of printer including replenishment of supplies
- Manual data entries
- Creation and editing of graphic operator display screens.
- Loading of any required software into the system
- Data base creation and editing.

Note: Contractor shall additionally refer to Part-15-Training & advisory requirements for complete training requirements.

End of Part-13